ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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The gross earnings of 143 railways for the month of May are $39,067,824, an increase of $824,832, or 2.16%, over those for the corresponding month of 1891, according to the "Financial Chronicle." This showing is less favorable than for any previous month of the year. The poor results are general throughout the entire country, but are especially noticeable in those sections most affected by the floods and bad weather. Of the 143 railways reporting, 50 show decreases in earnings, some of which are of considerable amount. The unfavorable exhibit is attributed to the floods and bad weather; the decrease in the movement of grain and cotton, and, in the Southern and Far Western states, to the general business depression.

The launching of the largest steamer ever built for the great lake traffic, took place at South Chicago, June 8. The vessel's name is the "Maritana," and she was built by the Chicago Shipbuilding Co. for the Minnesota Steamship Co. at a cost of $250,000, to engage in the Lake Superior ore carrying trade. Her tonnage is 2,800, length over all 350 ft., length at keel 330 ft., beam 45 ft. and depth 24½ ft. She has triple expansion engines 24, 39 and 63 ins. in diameter, with 48-in. stroke, steam being furnished from three steel boilers, tested to bear 160 lbs. of steam. With the present low stage of water the new craft will carry about 3,000 tons, and her speed will be about 14 miles an hour. In outfit she will have all the latest and most improved machinery for the quick handling of freight, and will be lighted throughout by electricity.

The Harlem River drawbridges at 3d. and 4th Aves. New York, are not to be abandoned, as the Senate Committee on Commerce, acting on the recommendation of Major Gillespie, U. S. Engineers, has agreed to report adversely the bill to authorize bridges over the Harlem River with fixed spans instead of draws and to limit the opening of the draws of the present low bridges to 4 p. m., during the construction of the new bridges.

The extensive equipment of new locomotives for the Southern Pacific Ry. will much facilitate the handling of the traffic. Of 30 engines built by the Schenectady Locomotive Works, 20 are twelve-wheel two-cylinder compounds for freight traffic on the Sacramento Division from Sacramento to Truckee, and the others are ten-wheel engines for the passenger service between San Francisco and Lathrop and Sacramento. The passenger engines now in use on the Western Division are too light for this service, and it has been necessary to run the overland trains from Oakland to Sacramento and Lathrop in two sections, but the new engines are intended to do away with this arrangement, which has caused considerable trouble. On the Sacramento or mountain division the freight traffic is very heavy, but the engines are not able to handle more than 12 or 15 cars, and thus a great many trains are necessary. Under the present system two engines are always used on trains, whether heavy or light, but the new engines will obviate this necessity, and add greatly to the facilities for moving freight generally. Sixteen new cabooses for this division have been built in the Sacramento shops, and 22 new passenger cars have been built by the Pullman Palace Car Co.

A novel method of blowing out the electric arc which forms on opening the switches is in use at the Deptford station of the London Electric Supply Co., and is described by Robt. M. A. Llyd in a recent issue of "The Electrical World." Electricity is generated at this station at the high tension of 10,000 volts, and is transmitted at that tension to the Charing Cross transformer station, seven miles away. The writer says:

One feature of the Deptford Station that I have not seen described before is the method of blowing out the arc at the dynamo switches. These are large manual switches, with a double pole, 4-ft. break. While one attendant opens the switch, another stands by with an instrument somewhat resembling a canoe paddle, having a flexible leather blade, and with this clubs out the arc. Spark magnets and blowers of every description have been tried, but I was assured by Mr. McLean, the Superintendent, that this was the most practicable device so far suggested.

Knocking down a 10,000-volt. current with a club is a feat that few would care to practice, for fear of reciprocal results. Mr. Lloyd also has the following note concerning the ventilation of the City & South London tunnels:

The absence of ventilation in the tunnels is the most conspicuous feature of the entire installation. Mr. Grindle, the resident engineer, explained to me that the air was so bad above ground that there could be no object in introducing it below. A little air does go into the elevator cars when they are opened at the top of the shafts, and walks out with the passengers at the bottom, but anyone whose windpipe has not been already seasoned by the steam roads underground can do nothing but gasp while in these electrical tubes.

The tubular frame freight cars described in our issue of April 28 are very favorably regarded by some of the railways using them. On the Nitrate Railways, Peru, where over 200 of these cars are in use, the economy in maintenance and repairs is estimated at 60% less than for the ordinary wooden cars on "bogie" trucks, because there is very little to get out of order or repair. The only expense for maintenance is the renewal of brasses and brake shoes. On the Great Northern Railway, of Ireland, they are found very economical and have an earning capacity far in excess of the ordinary short wooden cars, although the tubular frame cars are confined to mineral traffic and are generally returned without waiting for return loads, while the ordinary cars are used for mineral and general freight traffic. This railway has requested the Tubular Frame Wagon Co., of London, to consider the building of cars on this plan to meet the cases of smaller consignments of freight for thinly populated districts.

The most serious railway accident of the week was a freight train wreck caused by a washed out culvert near Hartford, Wis., on the Chicago, Milwaukee & St. Paul Ry., June 7. The culvert was of masonry, and was too small to carry off the water caused by a heavy rainfall. Three men were killed, and several cars were wrecked.—A serious derailment occurred June 10 on the Atlanta & Chattahoochee electric railway, at Atlanta, Ga. Owing to damage to the generating plant by lightning an old steam locomotive was being used. A train consisting of two cars pushed by the engine was rounding a curve on a high bank when both cars were derailed and went down the bank, one on each side. Five persons were killed and seven injured.

A locomotive boiler explosion occurred June 14 near Climax, Mich., on the Chicago & Grand Trunk Ry. Three men were fatally injured.

The boiler of the cooking range in the private car of Mr. Theodore Voorhees, General Superintendent of the New York Central & Hudson River R. R., exploded about 4 p.m. June 8, while the car was running from Rochester to Syracuse, N. Y. The water in the boiler in connection with the kitchen range got low, and the boiler exploded with great violence. The partitions forming the kitchen were torn from their places and ruptured, and everything in the kitchen badly broken. The cook was severely scalded, and in jumping through the glass of the door cut himself very badly on the wrists. It was thought that his injuries would result fatally, but he is now out of danger.

A tornado in Illinois did considerable damage at Chicago and other places June 13. A portion of the Manufacturers' Building, at the World's Columbian Exposition, was blown down, the building being in an incomplete condition. In Chicago eight persons were killed and 15 injured by falling buildings.

Block signals and interlocking plant are to be extended on the Chicago & Northwestern Ry., and a contract has been given to the Union Switch & Signal Co., of Pittsburg, Pa., for the equipment of the tracks from the Wells St. station, in Chicago, to Deering, on the Milwaukee Division, and West 40th St., on the Galena Division, with pneumatic interlocking and block signaling apparatus. There will be interlocking plants at the yard terminals and drawbridge, at Clybourne Junction, at the Deering drawbridge and St. Paul crossing, and at Western Ave., on the Galena Division. In addition there will be several smaller plants at various points in the yards where switches are grouped. Between the interlocking plants there will be automatic signals operated by the movement of trains on each block. The company has also a contract for the interlocking of the crossings of the Chicago & Alton, and the Atchison, Topeka & Santa Fe railways with the Belt railway at Lemoyne, near Chicago. This plant will have a 32-frame machine with 27 working levers and five spare spaces for extensions of the plant. The Chicago & Northwestern Ry. awarded a contract about six months ago to the Hall Signal Co., for the equipment of about 87½ miles of line, as noted in our issue of Feb. 6.

The electro-plating with aluminum of 6-ton cast iron columns 20 ft. high has been successfully accomplished by the Tacony Iron & Metal Co., of Philadelphia. The columns form part of the iron work to be placed at the top of the tower of Philadelphia's great City Hall, and the white metal at an elevation of over 500 ft. will harmonize well with the white marble of which the tower is built. The total surface of the iron work to be plated for the top of the tower is about 100,000 sq. ft. The castings to be plated are first soaked for a day in a bath of caustic soda, to remove grease, then for another day in an acid pickle to remove scale and oxide. They are then thoroughly cleaned with steel brushes and are ready for plating. A heavy coating of copper is first applied, and on top of this aluminum is deposited to a depth of 1-16 in. The total amount of aluminum used, if this thickness is maintained over all the surface plated, will be 520 cu. ft., or about 42 tons.

Some light on the question of the available supply of natural gas is furnished by the testimony in the suit of Carnegie, Phipps & Co. vs. the Philadelphia Co., recently tried at Pittsburg. The defendant company agreed some years ago to supply the mills of the plaintiff with natural gas, but recently it has cut off its supply to nearly all the mills in the Pittsburg district, in order to supply private consumers, who pay a higher price. The Philadelphia Co., in its reply, says that at the time the suit was brought the mills of the plaintiff consumed about one-fifth the entire supply, and it was impracticable to continue the contract. The defendant company has spent $3,000,000 in acquiring new fields and laying new mains in order to serve all its patrons, but the present supply is only about one-third what it was three years ago, and the supply to the plaintiffs' mills can only be maintained by cutting off hundreds of smaller customers, which the defendant company does not feel justified in doing, as it never agreed to furnish gas perpetually to the mills.

Since the shortage came the defendant has not engaged in supplying gas in new territory, but has confined its attention to old customers. The company's lines extend many miles from the gas field through the cities before the plaintiffs' mills are reached. Small consumers along the line are more favorably located, and it is impossible to furnish an adequate supply at the works without cutting-off those who are along the line. These smaller consumers have refused to voluntarily do without gas, and deny the company's right to carry it past them and deliver it to the plaintiffs, who are less favorably located.

The existence of a supply of gas even for the plaintiffs alone in the future is altogether problematical, and is furthermore dependent upon the exercise of the highest personal skill, knowledge and enterprise on the part of the defendant company in discovering new fields, and its further ability to expend vast amounts of money in acquiring new fields and laying new mains. The nature of the natural gas business is such that it is impossible to know that even three years from the present there will be natural gas within piping distance of the city of Pittsburg sufficient to supply the plaintiffs' mills.

Steel wire seating for railway car seats is being used in England, and is said to be taking the place of the padded and volute spring seats. The new seat is composed of minute steel wire rings compactly knit together, over which only a thin layer of hair or a pad of felt is necessary. The London & Northwestern Ry. has already fitted 653 to car seats and sleeping car berths, while the Great Eastern Ry. has in use nearly 5,000.

AMERICAN TYPES OF COMPARTMENT CARS; WAGNER PALACE CAR CO.

A train of corridor cars which has been built by the Great Western Railway, of England, and which has attracted considerable attention in England, was described and illustrated in our issue of May 5, and we now present plans showing the arrangement of some types of compartment cars built by the Wagner Palace Car Co., at its works at Buffalo, N. Y. In some of the English papers it has been stated that the Great Western Railway corridor cars combine the compartment system of English practice with the American system of communication throughout the train, and it has been claimed that American railways were adopting the compartment system, showing that the old-fashioned English practice was correct after all. As a matter of fact, however, the corridor cars are copied after the Mann boudoir cars, which were brought out in this country some years ago, and which have been introduced to some extent in Europe (Eng. News, Feb. 7, 1891). The object of these cars was to secure privacy for persons traveling long distances, but to avoid the extreme inconvenience and discomfort of the European system of compartment cars, with which passengers are imprisoned in the one compartment with no possibility of a change for comfort or for escape from unpleasant or dangerous fellow-passengers.

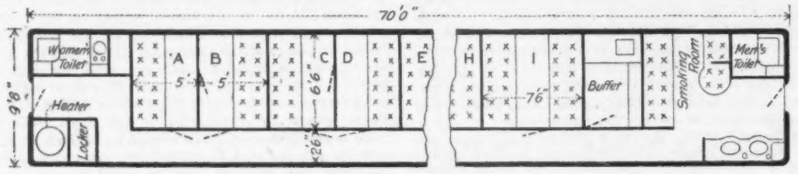


FIG. 1. COMPARTMENT CAR; WAGNER PALACE CAR CO.

The small plan, Fig. 1, shows an arrangement of a Wagner buffet boudoir car somewhat similar to that of the Mann boudoir cars, having the compartments partitioned off from the corridor. One somewhat objectionable feature of the arrangement is the open smoking room and men's lavatory. Some of the Wagner cars on this same general plan, however, have the toilet and smoking rooms separate and inclosed, and have the corridor on one side of the car for half the car length, and then on the other side, with a transverse connecting gangway 2 ft. 6 ins. wide across the middle of the car. Fig. 2 is a plan of the Wagner sleeping cars running on the Shore Line express of the New York, New Haven & Hartford R. R. between New York and Boston, and popularly known as the "zig-zag" cars, from the peculiar arrangement of the central corridor. In these cars there are state rooms and open sections alternately, the latter having lower berths only, while each stateroom or compartment has an upper and lower berth. These cars have also the open smoking room and men's lavatory, an arrangement which could readily be improved upon. The staterooms are 6 ft. 1 in. long and 2 ft. 4 ins. and 4 ft. 7½ ins. wide at the ends and middle respectively, and each stateroom has toilet fittings. There are eight compartments with sleeping accommodation for two persons, and eight sections with sleeping accommodation for one person, making a total sleeping capacity for 24 persons.

In the Wagner sleeping car of which the plan is shown in Fig. 3, the whole of the car is divided into compartments or staterooms about 6 ft. by 6 ft. 6 ins., each provided with lavatory arrangements, in addition to the usual end lavatories. The corridor is on one side of the car for half its length, and then on the other side. The interior finish of the compartments is of different kinds, some being finished in mahogany, others in Circassian walnut, others in English oak, and others in satin wood. The metal fittings are of nickeline. Between each pair of compartments is a sliding door.

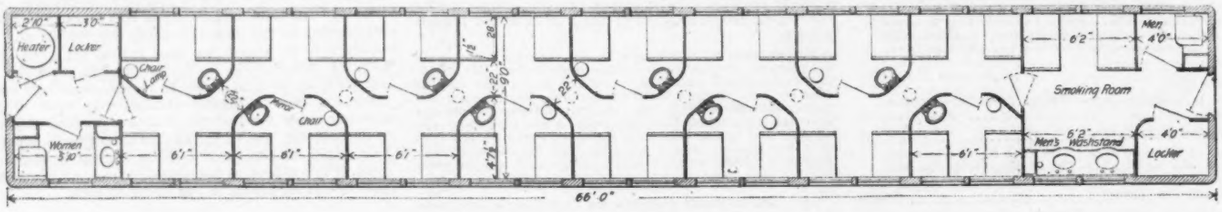


FIG. 2. COMPARTMENT SLEEPING CAR; WAGNER PALACE CAR CO.

Compartment cars are operated on certain trains of the leading railways by both Wagner and Pullman palace car companies, but the number in use is comparatively small, the ordinary forms of sleeping, drawing-room and parlor cars being generally used, and the latter are more profitable, as in the compartment cars the proportion of dead weight to paying load is very great, each compartment being reserved exclusively for private use, and not being available for general use as in the English corridor cars.

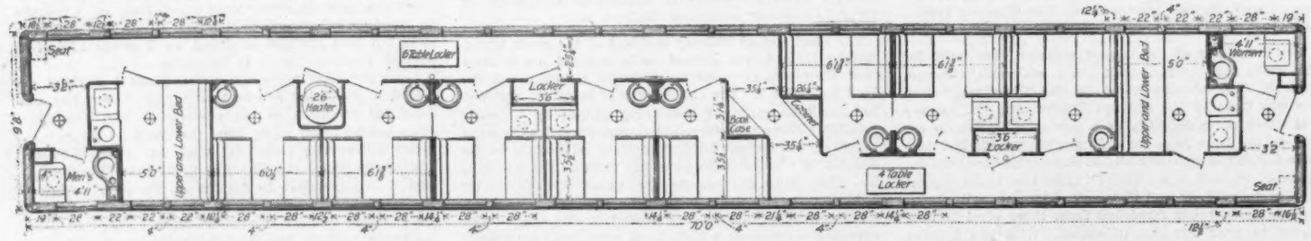


FIG. 3. COMPARTMENT SLEEPING CAR; WAGNER PALACE CAR CO.

TUNNELS AT ST. PAUL, MINN.

At the joint meeting in Minneapolis of the St. Paul Society of Civil Engineers and the Minneapolis Engineers' Club, May 21, Mr. Wilson, of St. Paul, read an interesting paper on the tunnels and caves at St. Paul, of which the following is a brief abstract. Mr. Wilson illustrated his paper by maps, drawings of the works described, and photographs showing the work in construction and the completed tunnels:

Although the location of the city of St. Paul is much diversified and broken, only one railway tunnel, that of the Northern Pacific R. R., has been constructed, but in the portion of the city which runs from the State Capitol to Fort Snelling, and from the river to the bluff, a great many tunnels for sewers, water mains and telephones are located. The geological formation of said district is Trenton limestone, 20 to 30 ft. thick, overlaying the so-called St. Peter sand rock, which is soft and can be picked and shoveled, and permits of easy tunneling.

There are about 20 miles of sewer tunnels, 3 miles of water-works tunnels, and ¾ mile of telephone tunnel, but besides these artificial tunnels, there are several natural ones, of which the two most noted ones are Carver's cave and Fountain cave. The so-called Carver's cave, discovered in 1766 by Jonathan Carver, is 150 ft. deep, 30 ft. wide and 15 ft. high, with a pool of water in it. Fountain cave, first mentioned by Major Long in 1817, is much larger than the other, the entrance is 25 ft. wide, 20 ft. high and 1,300 ft. long. Eight establishments, principally breweries, have large artificial storage vaults in this rock, some extending as far as 1,200 ft. in length.

In the before mentioned sand rock district of the city, 4½ miles by ½ mile, the sewer and water pipes are laid in separate tunnels, the sewer tunnels vary in size from 6 ft. by 2 ft. 6 ins. to 7 by 7 ft. The channels bricked for water to flow in these tunnels vary from 9×14 ins. to a horseshoe shaped section, 7 ft. wide. The water pipe tunnels are 6 ft. high and 3 ft. wide; 12-in., 6-in. and 4-in. pipes are laid in the tunnels. Connections with sewers and water tunnels are made by excavating a drift under the house and drilling down through the rock. The service pipe is then run through the drift and drill hole. The telephone tunnel is 3×6 ft., and has a capacity for over 1,000 wires in cables.

Some of the advantages of these underground tunnels for sewers, water pipes and telephones are, ease of access for examination, repairs and extension of new work; the great relief from tearing up the streets, and economy in cost.

ELECTRIC LIGHTING AT TOPEKA, KAN.

In the April number of the "Transactions of the American Society of Civil Engineers" is a paper by Mr. Lewis Kingman, City Engineer of Topeka, Kan., upon the electric lighting of that city, giving some interesting details of cost, from which we take the following:

The plant belongs to the city, and was purchased in 1888 from the Jenney Electric Co., of Indianapolis, Ind. It comprises 184 double carbon arc lamps rated at 2,000 c. p., three boilers, three Ball engines of 75 HP., with 80 lbs. steam pressure, and six dynamos of 30 arc lamp power, connected with six circuits, which together have 24.72 miles of line, and 33.5 miles of wire. The line is carried on 943 cedar poles 30 ft. long, and the lamps are suspended at the center of the street intersections between two 40-ft. poles. It was soon found necessary to use over 80 lbs. pressure, for which the boiler capacity was inadequate, except with best bituminous lump coal. Tests showed that the three engines had to work up to 235 HP. to keep the lamps burning regularly, and the average of tests of 17 lamps showed a pressure of 23.15 volts, a current of 19.0 amperes, and an electromotive force of 439.85 watts, or 1,953

nominal candle power. The lamps are placed at every other street intersection, and are about 1,100 ft. apart one way and 800 ft. the other way. The intervening intersections are not well lighted, which gives rise to some dissatisfaction.

What is needed is a system of lamps at every street intersection with one circuit covering the business portion of the city, with lamps of 1,000 actual c. p.; and circuits covering the residence and outlying districts, with lamps of 200 c. p. Objections to this would be the large additional number of lamps to clean and take care of, and the long distance of transmission of the current, with consequent loss or leakage. The present arc lamps are good, but the cost is too great to use them over a large territory. The Edison lamps have not the candle power necessary for street lighting, but the author considers that a system between the two would be suitable for many growing cities. The cleaning of the arc lamps and the globes is a large item of the expense, and is seldom done perfectly. A good clean globe absorbs 15% of the light, an opal globe 70%, and a dirty globe about 70%. The rods of an arc lamp must be kept clean or it will fail to burn, and the cleaner is at once reminded of his duty; but he can allow the globes to become obscured so that from 50 to 70% of the light is absorbed, without any serious complaints from the average citizen. The following table is the summary of a table of the cost of operating plant for the 26 months, November, 1889, to December, 1891, both inclusive:

Table of Cost of Operating the Municipal Electric Lighting Plant at Topeka, Kan., for 26 Months.

	Totals.	Percent. of total expenses.
No. of nights	672	....
No. of hours	5,430.17	....
Aver. number of hours run	8.08	....
Coal, tons	3,587.03	....
Coal, cost	$9,646.16	26.04
Coal, cost per HP. per night	6.11 cts.	....
Coal, cost per HP. per hour	6.76 cts.	....
Cost of carbons	$2,146.11	5.79
Cost of globes	159.05	0.43
Cost of oil and waste	501.35	1.36
Cost of repairs	3,045.78	8.23
Expen. insurance and telephone.	905.84	2.45
Pay-roll of supt. and labor	13,420.99	36.21
Interest on cost of plant, at 6%	7,208.24	19.46
Total cost of operating	37,036.52	100.00
Cost per lamp per month	7.74	....
Cost per lamp per 100 hours	3.74	....
Cost of lots and buildings	8,559 33	....
Cost of plant, poles and wire	46,888 65	....
Total first cost	55,447.98	....

HEAVY FREIGHT ENGINE FOR THE IRON RANGE & HURON BAY RY.

There has been a remarkable growth in the size, weight and power of freight locomotives during the past few years, and we illustrate this week an extremely heavy twelve-wheel or mastodon engine built by the Brooks Locomotive Works, Dunkirk, N. Y., for the Iron Range & Huron Bay Ry. In a later issue we shall give details and drawings of the engine.

The engine is a very handsome and powerful-looking machine. It has the Laird guides, and the two middle pairs of driving wheels have blind tires. A peculiar feature which is very noticeable is the rectangular sandbox mounted on the Belpaire firebox. The boiler is of enormous size, 5 ft. 8 ins. diameter at the smokebox end, and 13 ft. 10 ins. long between tube plates, and it carries the unusually high working pressure of 180 lbs. per sq. in. The connecting rods are of I-section and the side or coupling rods of rectangular section. The total weight of the engine is 162,000 lbs., of which 136,000 lbs. are on the driving wheels, or 17,000 lbs. per driving wheel. We understand that the rails the engine is to run on weigh 80 lbs. per yd., and certainly a substantial and well maintained track is very desirable for engines of such weight, both in regard to the maintenance of track as well as for the performance of the engines. The leading dimensions and particulars of the engine are as follows:

Cylinders	20 × 26 ins.
No. and diam. of driving wheels, 8	4 ft. 8 "
" " " " truck wheels, 4	2 " 4 "
Diam. of boiler barrel (at smokebox end)	5 " 8 "
Working boiler pressure	180 lbs. per sq. in.
Firebox, form	improved Belpaire, W. T. 6 ins. rise.
" size at grate	9 ft. 6 ins. × 2 ft. 9 ins.
Tubes, number	291
" diameter	2 ins.
" length	13 ft. 10 "
Wheel-base, driving	15 " 6 "
" truck	5 " 10 "
" total of engine	25 " 0 "
" engine and tender	52 " 0 "
Weight on driving wheels	136,000 lbs.
" on truck	26,000 "
" of engine, total	162,000 "
" of tender	78,000 "
" of engine and tender	240,000 "
Capacity of tank	4,000 gallons.
" of coal space	17,000 lbs.
Brake fitting	New York Air Brake.

RAILWAY STATIONS AND BUILDINGS.

The following is an abstract from a lecture on civil engineering given recently at the Young Men's Christian Association, Brooklyn, N. Y., by Mr. J. D. Fouquet, Architect for the New York Central & Hudson River R. R.:

The designing and arranging of plans for both passenger and freight stations, as well as for the minor structures is something of a specialty, requiring both engineering experience and architectural skill. It is only within a comparatively short time that railway corporations have called in the services of professional architects, and in most cases when the architects have been allowed to do their work independently of the engineer, or have not availed themselves of his familiarity with the requirements of the railway, and its interests and workings, the results have been anything but satisfactory, for the engineer acquires by education and long experience a knowledge of the adaptation of each particular structure to the branch of the business for which it is required, and every architect who has designed buildings for railway companies knows well that his work gives better satisfaction when done in connection with the engineering department of the road.

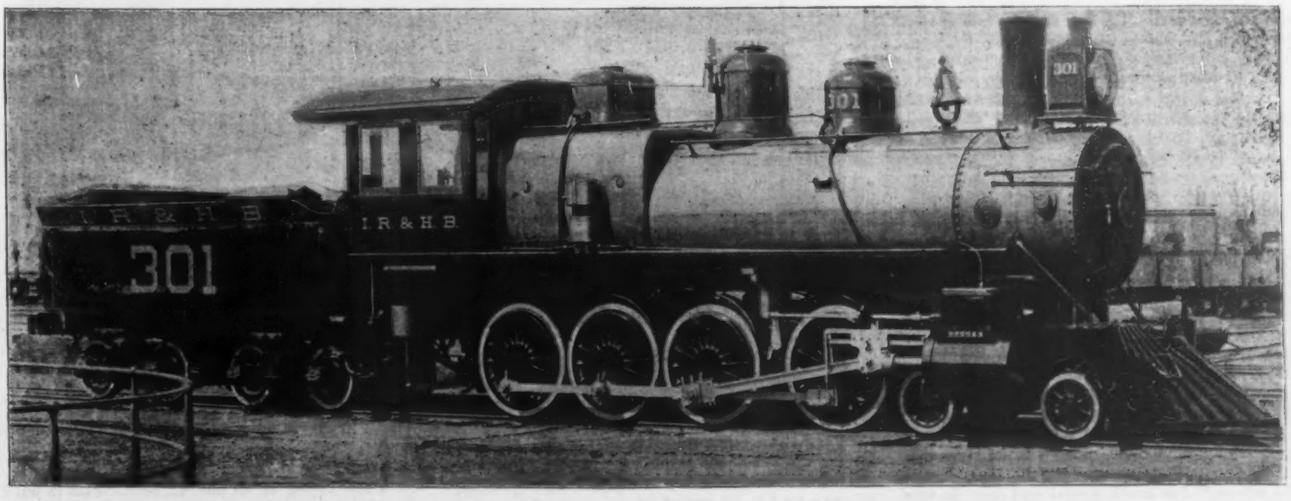
For years it was the practice of the companies to have such plans as they required for passenger and freight stations and subordinate structures prepared in the engineering department with a view not only to economy, but to insure their being strictly in accordance with the requirements of the particular cases in hand, without much regard to form, symmetry or artistic features, nearly everything being sacrificed to cheapness. Great improvements have been made of late in this respect on most of the leading railways in regard to the character of station buildings, and the comfort and convenience afforded thereby are certainly appreciated by the traveling public.

Primitive stations put up generally throughout the country 35 years ago were anything but picturesque when viewed from the present standpoint. They, however, answered the requirements of that time as well as did the old passenger cars of the same period, which have since given place to the greatly improved and luxurious cars of the present time.

The improvements in passenger stations have hardly kept pace with those of roadbed and rolling stock, but they are gradually falling into line, and before many years have passed a railway without first-class passenger and freight stations will be considered behind the age and open to public censure.

TUNNEL LIGHTING BY ELECTRICITY.

The Batignolles tunnel, just outside the St. Lazare station of the Western Railway, in Paris, is to be lighted by electricity. It is said that it has frequently been proposed either to open up the tunnel or to light it efficiently, not only on account of the inconvenience to passengers, but also because recent events have proved that the tunnel constitutes a serious danger to the workmen upon the railway. The railway company has definitely decided to adopt the system of illumination invented by M. Brochon. Under this system 900 incandescent lamps will be disposed along the tunnel, 150 along each side of the three sections. They will be placed at a height 15.75 ft. above the rails, and each lamp will be inclosed in a strong sheet iron box, the light being thrown on the wall by means of a powerful reflector. This light will be received by plates of burnished tin, covered with glass, which will be placed at a height of 6.56 ft. These will in turn reflect a soft and agreeable light into the cars. In order to economize as much as possible, the lamps will be automatically lighted by the train, and only that part of the two walls directly opposite the train will be at one time illuminated. But as sudden change from bright light to darkness would constitute a danger to the trackmen, it is proposed to place 20 lamps overhead in each section of the tunnel, and these will be kept permanently lighted. It is also intended to introduce a decidedly novel feature for the benefit of the passengers. Besides a limited number of advertisements, it is said that reading matter will be provided along each side of the tunnel. By an automatic process quotations on the Bourse, the latest news telegrams, winners of horse races, and other matters of interest will be displayed, and as the train slows down before entering the tunnel it is said to be easy for the passengers to read what is displayed. The work is now being proceeded with.



HEAVY FREIGHT LOCOMOTIVE, IRON RANGE & HURON BAY RY.; Brooks Locomotive Works, Dunkirk, N. Y., Builders.

THE HUNT INDUSTRIAL RAILWAYS.

The enormous development of manufacturing industries, during which the factory has replaced the shop, and great "works," covering many acres of ground, have in many cases replaced the factory, has made the question of "internal transportation" an important one to many manufacturers. The old-time cobbler, for instance, sat on his leather-seated bench with his kit of tools at his side, and with hardly a move from his seat would perform all the processes necessary to the making of a shoe, from

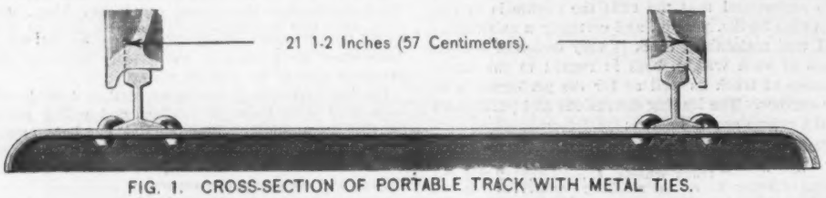


FIG. 1. CROSS-SECTION OF PORTABLE TRACK WITH METAL TIES.

cutting out the leather to the final polishing. In the modern shoe factory, with hundreds of employees, division of labor and machine work have greatly increased the distance of travel of the various parts of the finished shoe, from their entry as raw material to their exit ready for the market. In the various metal industries and others producing heavy or bulky materials on a large scale, transportation about the works is still more important. In some great establishments one who follows the raw material through all its stages to its final completion may travel a mile or more; and just as manufacturers located a considerable distance from railways have found that a haul of a few miles by wagon may eat up more profits than a hundred miles haul by rail, so those in charge of large works find that the expense of internal transportation forms often no insignificant proportion of the total manufacturing cost.

In buildings of several stories, having smooth floors, where the materials to be moved are not too heavy, light four-wheel trucks are perhaps the most desirable system of transportation, as they can be run anywhere, and are easily transferred from one floor to another by elevators. But where the weights to be moved are large and the distances are considerable, especially where work is carried on in one-story buildings covering a large area, it is generally the practice to establish some sort of a railway system to connect the various parts of the establishment.

It is to meet this need of a railway system as well adapted to this especial purpose as the standard railway system is adapted to its purpose that the various details of the Hunt industrial system of railways have been worked out. The principal details in which it differs from the standard railway system are the narrow gage (21½ ins.) and the rolling stock used, which has wheels with flanges outside instead of inside, and a "flexible" truck permitting the axles to take a radial position in rounding curves, which they readily do by the use of a special rail on the outside of the curve on which the outer wheel rolls on its flange. Of course, wherever it is desired to run an ordinary freight car into a works, there a standard gage track should be laid, and the narrow gage track can be laid between its rails if desired.

In advocating this gage Mr. Hunt says truly that the load which can be carried upon a railway depends not upon its gage, but upon the strength of its track and rolling stock. For a railway which is to ramify through a manufacturing establishment, the narrower the gage, the less room is taken up by the track and the sharper the curves which may be turned, permitting every corner of a shop to be reached without the use of turntable. Of course, the gage must not be made so narrow as to endanger stability. How narrow it can be made depends upon the speed which it is desired to attain in rounding curves. The present standard gage of the Hunt system was first adopted on cars for the Hunt "automatic railway" for handling coal and ore. It was then applied to the industrial railways; and although when it became necessary to introduce locomotives for handling the traffic on these little roads the question of a wider gage was seriously considered, it was finally decided that nothing was to be gained by it.

The track for these railways is made of various weights according to the load to be carried. An ordinary T rail weighing 12 to 20 lbs. per yd. is used, and with various weights of rail it is recommended that the following loads on a four-wheel car should not usually be exceeded:

Weight of rail	12 lbs.	16 lbs.	20 lbs.
Load on car	6,000 lbs.	10,000 lbs.	15,000 lbs.

The standard track is made up in sections 20 ft. long, riveted to steel cross-ties of the section shown in Fig. 1. The ties are spaced 24½ ins. c. to c., with the joint ties closer. On a dirt, gravel, or cinder foundation such a track can be filled in level with the top of the rail, as no flangeway has to be left on the inside. Plank or concrete may also be filled in between the rails where desired. For laying the track on wooden floors a flat strap-iron tie is used, raising the track as little as possible above the floor.

A cast iron plate track is also furnished where desired, but costs about three times as much as the regular track. Switches are made with standard radii of 12 ft. and 20 ft., and curves are made of 12 ft., 20 ft., and 100 ft. radius, and of any desired length. Crossings and turntables are also furnished, the latter resting on a ring of 67 steel balls, enabling a heavy load to be turned by one man. The outer rail on all switches and curves carries the car wheel on the point of its flange instead of on its tread, thus making the resistance no greater than on a straight line, and saving the wear from slipping which occurs on a curve ordinarily.

Of course the bodies of the cars used with these railways vary greatly according to the special use to which they are put. The running gear of the car, however, is practically uniform and is of very ingenious construction. Fig. 2 shows the truck of a four-wheel flat car. The bearings are on the outside of the wheels. The frame which carries the bearings for each axle is made in one piece, which reaches around the outside of the wheels and has a tongue which projects over the center of the axle. In this tongue directly over the axle is the king pin, on which the body of the car swivels, thus permitting the axles to assume radial positions in rounding a curve. Four-wheel cars of this pattern are made to carry loads of 2,000 to 20,000 lbs. The wheels used are chilled cast iron, 12 ins. diameter for the small sizes, increasing to 18 ins. diameter on the 20,000 lb. cars. Eight-wheel cars are made by placing a car body on two four-wheel trucks similar in design to that just described. Fig. 3 shows the two trucks of an eight-wheel car in the position taken in rounding a sharp curve. It also shows the center plate and side bearings which are used on the eight-wheel cars.

The four-wheel car, however, is preferable in all cases where the weight or bulk of the load is not too great. It not only rounds curves with great ease, but it does this no matter how long its wheel base, which is not the case with the ordinary rigid truck. Fig. 4 illustrates this remarkably well. It is from a photograph of a car made for carrying foundry ladles, built for the Brown & Sharpe Manufacturing Co., and the position of the axles in rounding a curve of 12 ft. radius is apparent. As the axles can be placed as far apart as is desired, the car body can be suspended between them, bringing the floor down only a few inches above the rail level. This is but a sample of the manner in which the car bodies can be varied to suit special needs.

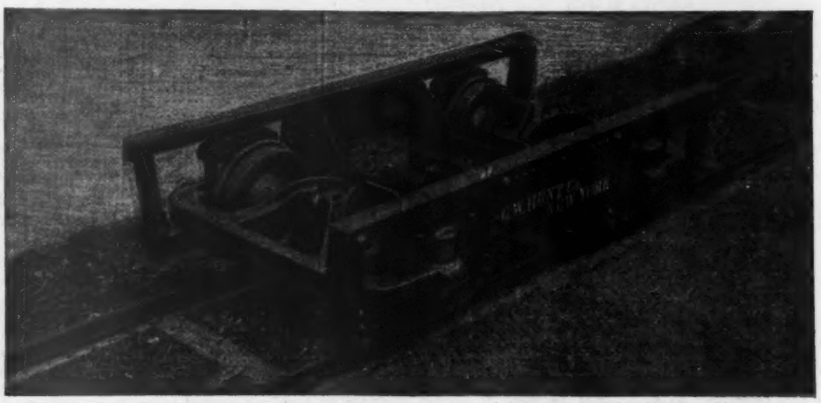


FIG. 2. RUNNING GEAR OF FOUR-WHEEL CARS, WHEELS WITH FLANGES OUTSIDE.

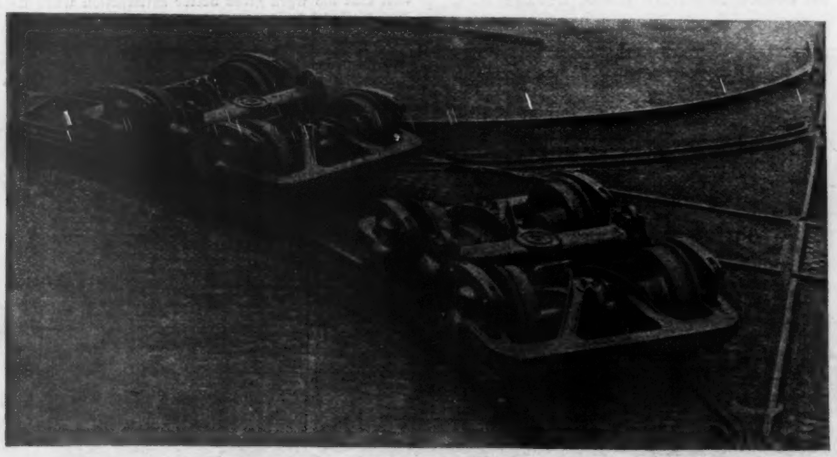


FIG. 3. TRUCKS FOR EIGHT-WHEEL CARS.

In establishments of moderate size the cars are pushed about the works by man power, or if necessary are drawn by horses. In very large works, however, there is a demand for some form of mechanical traction; and in some cases, as, for instance, large steel works, as many locomotives are employed

as on railways of considerable importance. The C. W. Hunt Co. began experimenting some years ago to meet the demand for mechanical traction, and built a very powerful locomotive on the Fairlie plan, which rounded with ease curves of 12 ft. radius. There was a four-wheel driving truck at each end of the locomotive, each having a pair of cylinders. The

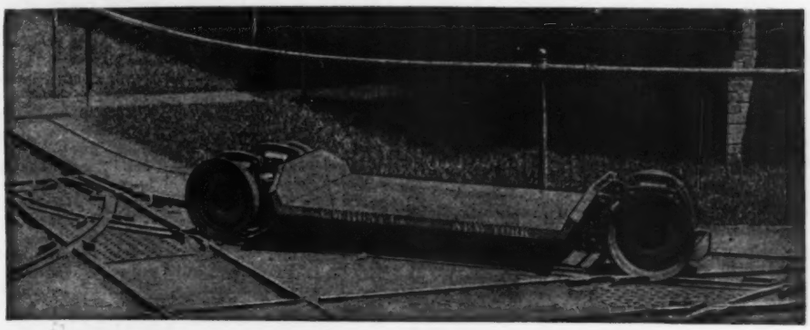


FIG. 4. CAR FOR CARRYING FOUNDRY LADLES, MADE FOR BROWN & SHARPE MFG. CO.

objections to steam locomotives about shops are numerous, however. Besides danger from fires, the noise, smoke, gas and steam are a nuisance in running inside buildings, and the company has turned its attention to electricity, in the belief that in the great majority of cases electric traction for industrial railways is much to be preferred. Much hopes of the storage battery as a convenient and economical source of power were at one time entertained by the officers of the company, but at present the overhead wire is considered the most practical and satisfactory means of operating electric locomotives. As a rule, the tracks on which locomotive work is required will be so restricted that the stringing of the trolley wires will not be as complicated a task as might at first appear.

Fig. 5 shows a four-wheel electric locomotive arranged for mine use. The motor is placed at one end and drives a crank shaft connected to the driving wheels by connecting and coupling rods as shown, thus utilizing all the weight of the motor for traction.

Where greater tractive power is needed than can be secured with the permissible weight on four

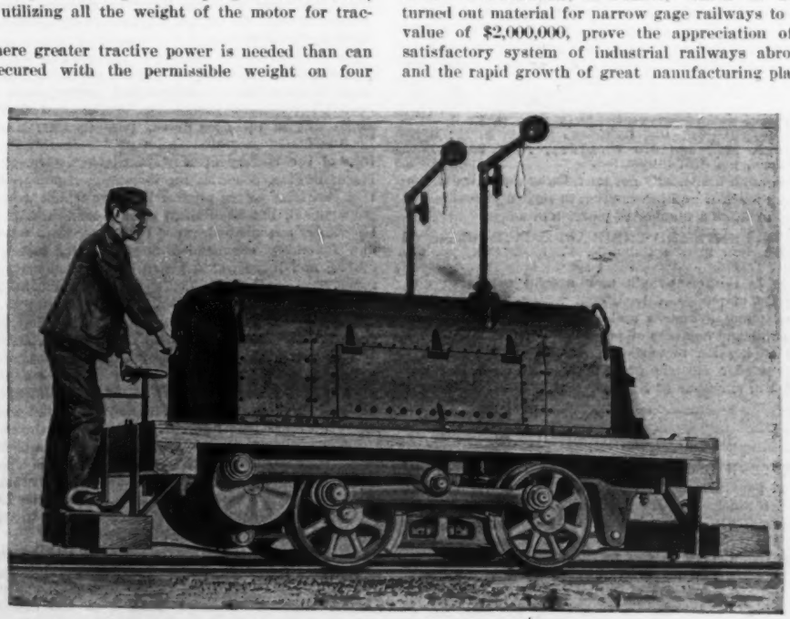


FIG. 5 FOUR-WHEEL MINING LOCOMOTIVE; WHOLE WEIGHT AVAILABLE FOR TRACTION.

wheels, an eight-wheel locomotive is built, and Fig. 6 shows the ingenious method of transmitting the power from a single motor to the eight driving wheels. The motor is mounted at the middle of the car body and drives a shaft running lengthwise of the car, carrying a bevel gear wheel on each end. These gears mesh into larger gears mounted directly on the crank axles, which are connected to the drivers as in Fig. 5. Between the motor and the gear is a universal coupling and an elastic joint. The former permits the trucks to swivel on a curve and the latter relieves the gears from sudden shocks and strains. The gears run in a bath of oil, and while the arrangement would hardly be suitable for street railway work, for the moderate speeds for which it is intended, we see no reason why it should not work with success.

The extent of the field for light narrow-gage railways is not generally realized, but it is certain that their use is destined to rapidly increase. The great works of Decauville, in France, which in 1889 turned out material for narrow gage railways to the value of $2,000,000, prove the appreciation of a satisfactory system of industrial railways abroad; and the rapid growth of great manufacturing plants in this country will certainly be accompanied with similar development in systems of internal transportation.

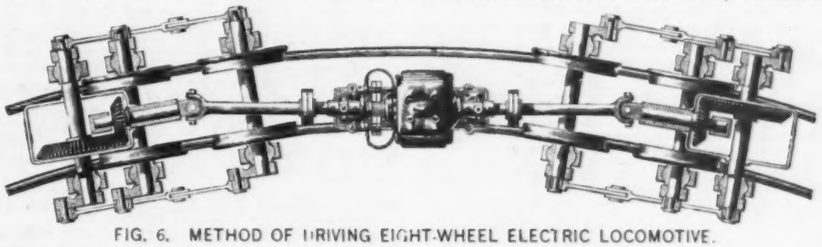


FIG. 6. METHOD OF DRIVING EIGHT-WHEEL ELECTRIC LOCOMOTIVE.

SHIPBUILDING IN GREAT BRITAIN.

In a lengthy article on "The World's Shipbuilding in 1891," published by the "Chronicle," of Newcastle, England, the total production reported for the United Kingdom is given as follows:

Year.	Tons.	Year.	Tons.
1881	1,000,000	1887	578,053
1882	1,200,000	1888	903,687
1883	1,250,000	1889	1,302,889
1884	750,000	1890	1,279,077
1885	540,422	1891	1,209,904
1886	473,675		

The decrease in tonnage for 1891 is said to be largely in ocean-going steamers. Referring to the United States, the "Chronicle" has the following paragraph, which is of particular interest just now in view of the recent action of Congress in permitting American owners to fly the American flag on vessels built abroad:

> There is the probability of a coming competitor in shipping, for the United States is becoming restive at finding that all its goods are practically carried to Europe by the fleets of other nations; and in some way or other it will try, it seems probable, to raise a fleet of merchant vessels, just as it has been building a navy. Possibly the coming electoral disputes in that country may postpone for a year or two the decision, but it seems one of the things that loom ahead, and that will force us to consider how our steamers can work cheaply enough to compete with the vessels that the United States will seek in some way to "protect." There is open competition on the seas, and the bounty system has failed with France; but America approaches it in another fashion, and the ship owners of Great Britain will need to watch every move that is made on the chessboard of the politics of the United States. It is a difficulty that is ahead; that has been clearly indicated by the passing of the postal subsidy act by the last Congress; but one which is lessened by the fact that the surplus of the United States has been frittered away by lavish pensioning. Still, the temper of the politicians of that great country is shown, and to meet a competition that seems to be coming the shipowners will need cheaper working. There is a continuous growth in the oversea traffic of the world, and the competitors who can carry cheapest and quickest have the greatest likelihood of being able to secure the largest share of that trade which has been so valuable in the past and is still of such importance to this country.

In our issue of June 2 we gave a comparison for four years back of British and American iron shipbuilding, which showed encouraging progress in this country in those four years from 36,719 tons in 1888 to 105,618 tons in 1891. The indications seem to be that this marks the beginning of a real and permanent recovery of our shipbuilding interest, and if so it may not take us long to reach and pass the half-million tons or so which Great Britain was building in 1885-7. If the raw material were as cheap here as abroad there would be a still stronger chance that this will be the case, and still less doubt that the wages earned in such a shipbuilding trade as Great Britain's would vastly exceed those earned in producing the raw material. It is to be noted, however, that a little more than half of our shipbuilding is still on the lakes.

PERSONALS.

Mr. E. L. Shaw, has been appointed City Engineer of Marinette, Wis.

Mr. George F. Green, the inventor of the first electric street car, died at Kalamazoo, Mich., June 8, at the age of 60.

Mr. J. F. Babbitt, Jr., has been appointed Purchasing Agent of the Central Railroad & Banking Co. of Georgia, with offices at Savannah, Ga.

Mr. J. D. Trammell has been appointed Resident Engineer of the International and Great Northern Ry., with headquarters at Palestine, Tex., vice Mr. Tobin, transferred.

Mr. O. F. Jordan has been appointed Superintendent of the Canada and Michigan Midland Divisions of the

Michigan Central R. R., vice Mr. J. B. Morford resigned. Mr. Jordan's office will be at St. Thomas, Ont.

Mr. A. W. Gibbs, Superintendent of Motive Power of the Central R. R. of Georgia, has resigned, and the office has been abolished. The duties will be divided between the General Superintendent and the Master Mechanic.

Mr. E. P. Hannaford, Chief Engineer of the Grand Trunk Ry., has been given charge of the Midland Division, with Mr. J. G. Maclin as assistant. Mr. Joseph Hobson, Chief Engineer of the Great Western Division, will also take charge of the Northern & Northwestern Division, with Mr. H. Holgate as assistant.

Mr. J. A. L. Waddell, of Kansas City, Mo., has resigned the Western Agency of the Phoenix Bridge Co. and the Phoenix Iron Co., which agencies he has held since Jan. 1, 1887, in order to be able to attend to his practice as a consulting bridge engineer. His resignation will take effect July 1.

Mr. A. C. Stites, who has been Mr. Waddell's principal assistant for four years, will take the agencies of the two companies, with headquarters in the Laclede Building, St. Louis. Mr. Stites will also take charge of a branch engineering office for Mr. Waddell, whose main office will still be at Kansas City.

Mr. James E. Serrell, a City Surveyor of New York, died in this city June 10. He was born in London, England, in 1820. In 1845 Mayor Harper, of New York, appointed him a City Surveyor, in which capacity he was connected with many of the public improvements, including the grading of Second Ave., the 39th St. sewer, the widening of Broadway from 34th to 59th St., and the surveys for the city's public buildings on Wards and North Brother Islands.

Mr. Sidney Dillon, the well known railway man and financier, died in New York, May 9, at the age of 81. He was born at Northampton, N. Y., in 1812. The following account of his life is an abstract from a lengthy article in the New York "Times":

As a boy he was employed by the contractors who were building the old Mohawk & Hudson Railway, from Albany to Schenectady, it being one of his duties to carry water to the laborers employed on the grading. For his services he was paid $1 a week.

When this work was finished, young Dillon was employed in humble tasks on the Rensselaer & Saratoga line. Then Jonathan Crane and John T. Clark, who had a construction contract at Sharon, on the Boston and Providence Ry., gave him a place as foreman. To reach Sharon, Mr. Dillon and a few others traveled by wagon from Schenectady. It was a trip of over 200 miles, and they had to carry their own provisions with them.

Two years later he became manager for Carmichael, Fairbanks & Otis, and looked after work on the Stonington R. R., and the Western R. R. of Massachusetts. The engineer in charge of the latter road advised him to try his fortunes as a contractor, and acting upon this counsel, he received an allotment of contract being completed in 1840. He then undertook a difficult task on the Troy & Schenectady Road, where he first used a steam excavator, and then individually or with partners he carried out construction contracts on the Hartford & Springfield, the Cheshire R. R., of Vermont, the Vermont & Massachusetts, and the Rutland & Burlington roads. In two years a firm, of which he was a member, Boddy, Ross & Dillon, built 20 miles of the Central Railroad of New Jersey. Other of his undertakings were contracts on the a section near the western end of the line, his first New York Central, the Philadelphia & Erie, and the Erie & Cleveland railways. Later on Mr. Dillon had construction work on the Boston, Hartford & Erie, the New Orleans, Mobile & Chattanooga, and several other lines. One of his greatest undertakings was the Fourth Ave. tunnel of the New York Central R. R., in New York, which cost about $7,000,000.

Mr. Dillon was well advanced in life when he became interested in the greatest enterprise of his life, the construction of the Union Pacific Railway. It was practically a race for mileage, and in the management of the construction company his experience as a railway builder proved to be of great benefit, although, of course, the details of the operations were left to subordinates. From 1865 Mr. Dillon was interested in the fortunes of the Union Pacific, first in the building of its line, and afterward in the management of the property. In four years he saw 1,100 miles of track constructed, and then, in 1869, took a prominent part in the ceremony of laying the last rail to make connection with the Central Pacific Ry., at Promontory, 75 miles west of Ogden. He saw many years of service as an officer of the Union Pacific Ry. Co., and was long a member of the Executive Committee of the Board of Directors, finally succeeding Mr. Horace F. Clark as President. The road had its troubles, and plenty of them, and the disputes over its relations with the Government and the various investigations of its management resulted in bringing everybody connected with it prominently before the public. In 1884, Mr. Dillon was succeeded as President by Mr. Charles Francis Adams, who represented the Boston interests.

In the last few years Mr. Dillon retired from some of the directorships and other offices he held, but he was still on the board of numerous corporations. Among them were the Manhattan Elevated Ry. Co., the Western Union Telegraph Co., the Missouri Pacific Ry., and the Mercantile Trust Co. He also had large interests in the Missouri, Kansas & Texas Ry., the Delaware, Lackawanna & Western R. R., the Pacific Mail Steamship Co., the Wabash Ry., and the Texas & Pacific R. R., and others. At one time he was Vice-President of the Central Railway of New Jersey, and in 1867 he acted as its executive officer while President Johnston was in Europe.

As a railway man Mr. Dillon was primarily a constructor. Individually or in connection with other contractors he built thousands of miles of road, east and west, north and south. Twenty years ago it was estimated that the contracts in which he had been interested, represented expenditures running up to $75,000,000, and the construction of over 2,500 miles of track.

NEW PUBLICATIONS.

THE MICROSCOPICAL EXAMINATION of Potable Water. By Geo. W. Rafter, C. E., New York; The Van Nostrand Co.; 18mo., pp. 160; cloth, 50 cts.

This excellent little book is noticed at length elsewhere in this issue. We regret to say that it has neither an index nor table of contents, but this omission is not so important as it would be in a larger work.

REPORT OF THE BOARD OF TRANSPORTATION of the State of Nebraska, for the year ending June 30, 1891. Pub. Doc; Cloth; 8vo.; pp. 129; with map.

With the exception of the eleven small tables, the value of which is largely eliminated for convenient use by neglecting to give totals for the figures of the various headings, this report is taken up with the discussion of rate questions and the hearings of complaints. There is nothing of technical interest.

THE RAILWAY OFFICIALS DIRECTORY.—A Guide for the Use of Railway Officials and Dealers in Railway Supplies, Giving the Names and Addresses of Chairmen of Boards, General Managers, General Superintendents, Purchasing Agents, Chief Engineers, Superintendents of Motive Power, Master Mechanics and Master Car Builders, of the United States, Canada and Mexico. Chicago, 1892. The Railway Age and Northwestern Railroader; leather; 16 mo., pp. 175.

The contents of this little book, formerly called the Supply Men's Directory, are quite completely given in the title. It is of convenient pocket size and neatly bound, and will undoubtedly be useful to supply men, for whom it is primarily intended.

JOHNSON'S TABLES.—Stadia and Earthwork, Four-Place Logarithms, Logarithmic Traverse Table, Natural Functions, Map Projections, etc. Reprinted from "Theory and Practice of Surveying," by J. B. Johnson, Prof. C. E., Wash. Univ., New York. John Wiley & Sons. 8vo., pp. 99. $1.25.

The nature of these tables is sufficiently indicated by the title. We long ago reviewed and approved of the volume from which the tables are taken. Typographically they are not particularly admirable, but we have no doubt they are accurate, and they should be convenient.

SPECIFICATIONS FOR BUILDINGS. Palliser, Palliser & Co., New York. 27 foolscap sheets.

These specifications are very full, leaving little except the entering of dimensions and quantities to be done by the architect. In fact, they seem to leave rather too little, since, in many places throughout the specifications (as, for instance, in the case of ash pits, mortar, shingles, floors, varnish), the names of particular manufacturers are specified (apparently for a consideration), so that the architect must either adopt the choice of Palliser, Palliser & Co. or else make very considerable erasure on the forms.

TRADE PUBLICATIONS.

SUMMER EXCURSIONS ON THE B. & O. R. R.—Passenger Department, Baltimore & Ohio R. R., Baltimore, Md., and 415 Broadway, New York. 1892, 12mo., pp. 376; illustrated.

This is an artistically got up railway guide book, containing much useful information in regard to routes and fares, and has a number of plates and maps.

POWER PUMPS AND THEIR APPLICATIONS.—Gould Mfg. Co., Seneca Falls, N. Y. 1898. 8vo., pp. 64. Illustrated.

This is the company's new special catalogue and price list of pumps, valves, etc., with tables of capacity of pump cylinders and other useful information. The catalogue has cuts of pumps, and pictures showing their application to various purposes. The company's three-cylinder electric pump was illustrated and described in our issue of Nov. 14, 1891.

SOCIETY PROCEEDINGS.

WESTERN RAILWAY CLUB.—At the meeting on May 17 papers were read by Mr. W. H. Lewis on "Locomotive Stacks and Exhaust Nozzles," and by Mr. E. M. Herr on "Irregular Wear of Locomotive Tires." They are published elsewhere in this issue. The subject of coach-cleaning was briefly discussed. Mr. J. N. Barr said that for cleaning the exterior of coaches the Chicago, Milwaukee & St. Paul uses a mild soap in almost liquid form, and the quality of the soap has a great influence on the durability of the paint. Some varnishes, however, will stand soap and washing much better than others. Some of the sleeping car companies use what is known as wood polish for claning interiors. Its principal component is an alkali that readily removes the dirt.

Mr. Lewis said that great success had been obtained on the Chicago, Burlington & Northern with oxalic acid in car-cleaning. It was at first supposed that it would injure the varnish, but careful tests showed there was no injury whatever.

The next meeting of the club will be held on Sept. 20.

ENGINEERS' CLUB OF PHILADELPHIA.—The regular meeting was held June 4, Mr. James Christie, President, in the chair; 30 persons present. The Secretary announced that at the last meeting of the Board of Directors Prof. L. F. Rondinella was appointed Secretary of the club, for the unexpired term of Mr. John C. Trautwine, Jr., resigned.

Mr. Henry G. Morris opened discussion on the location of the new mint by stating that he had seen in one of the daily papers a proposal to take as a site a part of South 6th St., which is said to be infested with consumption, destroy the present buildings with fire if necessary, and replace them with buildings in every way suitable for the business of the mint. He thought it strange that it should be proposed to erect, in connection with the mint, a gas plant for heating purposes, and that the city could not supply gas for that purpose, and indeed that it would not supply gas to consumers for less than $1.50 per 1,000 ft., while a city like Cleveland was able to supply it at 80 cts. per 1,000. At the same time he considered it very doubtful whether a new mint were necessary. Dr. Henry Leffman stated that we should hesitate to accept reports about diseased localities, for, from the results of his own investigations, he knew them to be generally unreliable. He thought, however, a better site could have been selected than the one fixed upon, from a commercial point of view, and that it would be a good thing to rebuild diseased districts of the city with any better structures.

Mr. Henrik V. Loss started a discussion on the "Shearing of Iron and Steel," by calling attention to the fact that while engineers were familiar with the action of other forces upon metals generally, they were yet much in doubt with regard to shearing. He considered hydraulic machinery the only available kind for accurate shearing tests, and described the results of a series of experiments that he had been making, but had not yet completed. From cards which he had taken he found that it requires more power to cut iron than steel of the same dimensions, and less power for both metals than is generally supposed. Mr. John C. Trautwine, Jr., attributed the differences in the behavior of these two metals to the brittleness of steel compared with the tougher iron, and called attention to observations similar to those of Mr. Loss in a paper by Mr. F. H. Lewis, entitled "Soft Steel in Bridges." (Eng. News, March 26.)

Mr. A. Falkenau cited a case of a breaking pin in a compressing machine which persistently sheared off very suddenly, sometimes even under a strain less than its elastic limit.

Other members called attention to the facts that steel tanks holding water rusted much more quickly than iron ones used for the same purpose, and that pipes carrying oil seemed to rust more quickly than those carrying water.

Mr. Loss asked the opinion of members on the proper proportioning of valves to cylinder areas in high-pressure pumps. He considered flat better than cone-seated valves, and thought the valve area should be about 30% of the area of the plunger. Mr. Max Livingston called attention to an article in the Proceedings of the Society of Mechanical Engineers, by Professor Denton, describing a Worthington pump, the action of whose valves produced results which were then phenomenal, but have since been exceeded. The Riedler valve, a recent German invention, was described and favorably commended upon by Mr. Morris and others, and there was a general discussion upon other types.

L. F. Rondinella, Sec.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—Annual Convention at Old Point Comfort, Va., June 8-13.—Considering that this convention was held at a point so far south that pretty warm weather might be expected, the attendance was very good; 157 members and 55 ladies signified an intention to attend, and about that number did so, although the number who attended throughout the convention was much less. About 60 members and ladies took a special train from New York on Tuesday morning, June 7, and about 80 others arrived otherwise for the first day's sessions. The meetings were held in the airy pavilion of the Hygeia Hotel, one of the pleasantest meeting rooms the society has ever had.

On Wednesday there was a morning and afternoon session for the reading of papers, and an evening session at which President Mendes Cohen presented the usual annual address. Availing himself of the discretion which is left to the president by the new constitution, Mr. Cohen took as the subject of his address the early history of the Baltimore & Ohio Railroad, with which he was especially familiar, instead of attempting the almost hopeless task of giving "a summary of the progress of engineering during the past year," as the old constitution required. His address was a very interesting one, and we shall hope to present a full abstract of it in our next issue. It was listened to with attention by a large audience and much applauded.

In opening the morning session Col. Wm. P. Craighill U. S. A., gratified a universal feeling of the members

present by moving a congratulatory resolution to Gen. Geo. S. Greene, who attended the convention with his son and grandson, and was still, to all appearances, as hale and hearty as if he were in his 73d instead of his 92d year. The resolution excited loud and prolonged applause, and was passed by a rising vote, the members vying with each other in expressing their pleasure at the resolution. It is quite certain that the presence of no member of the society is regarded with more pride and pleasure than is Gen. Greene's. He has been for some years the second oldest graduate of West Point, and is now, we believe, the oldest. He graduated second in the class of 1823, Maj. Alfred Mordecai being first.

The only paper read at the morning session of the first day was Mr. Foster Crowell's paper on "Uniform Practice in Pile Driving," in which Mr. Crowell compared some 16 different formulas, and gave the preference for practical use to what he christened the "Engineering News" formula; that, namely, propounded in our issue of Dec. 29, 1888, and which had the form:

$$\text{Safe load} = \frac{2\,wh}{s+1}$$

Mr. Crowell thought this formula could be improved, however, by making the constant 1 in this formula a variable of two to three terms, as will be more fully seen from an abstract of a paper which we shall shortly publish. In this we do not agree with him, for reasons which we will discuss later. The paper led to an animated discussion, which consumed the entire morning.

In the afternoon Mr. John B. Duncklee's paper on "The Iron Wharf at Fortress Monroe, Va.;" Mr. W. W. Coe's paper on "The Iron Coal Pier of the Norfolk & Western R. R. at Norfolk, Va.," and Mr Desmond Fitz Gerald's paper on "Rainfall, Flow of Streams and Storage," were read and discussed between 2 and 4 P. M., when the society adjourned to visit the Artillery School at this post, and to witness a review tendered by Col. R. T. Frank, U. S. A., commanding. The artillery school is very handsomely housed and thoroughly equipped. Its purpose is to give a two years' post-graduate course of instruction in the chemistry, mathematics and physics of modern artillery practice to the younger artillery officers, after they have seen two or three years' service. The drill is very thorough, and the grade of excellence demanded and achieved very high. The school is one of many features of our army and navy practice of which the general public knows little, but which combine to give us a service hardly equaled in efficiency, if generally surpassed in size.

We have already published the official advance abstracts of all the papers read at the convention, one or two excepted, which we shall abstract in this and following issues. We are unable to report any of the discussions at the convention, as we made no preparations to do so in view of the recently promulgated rules prohibiting such abstracts of papers or discussions. These new rules were "suspended" so far as this convention was concerned on the third day of the convention, but too late for those who had accepted them in good faith to make any preparations for such reports. Fortunately no discussions of very special interest developed at the convention, and of several of the papers we shall give new and fuller abstracts at a more convenient season.

The second day of the convention was wholly devoted to an excursion to Virginia Beach, a new and pleasant resort upon the ocean about two hours from Norfolk. A handsome modern hotel has been built there and a few cottages. Otherwise the beach is entirely deserted for miles each way. The sewage purifying works, on the system of Mr. Jas. J. Powers, 13 Boerum Place, Brooklyn, N. Y., were inspected with interest by a number of members and seemed well adapted to the requirements. A novel and successful device for raising the water level of the lagoons back of the hotel, and thus converting them from swamps into pretty lakes, deserved more attention than it received. A planked canal about 10 ft. wide and with a water level about 2 ft. above high water was carried through between the lagoon and the ocean. At the sea end this was defended on each side by very heavy piling (sunk by a water jet, we believe) and in front there was a heavily constructed ramp, made of piling, for the waves to dash up against. The tide rises and falls some 2 ft. only at this point. The effect is that all waves at high water and high waves at all stages dash up and over this ramp into the canal, thus maintaining the high interior level. The simple and inexpensive plant seemed to work perfectly and maintain the higher water level with ease.

On the road to Virginia Beach, a visit of some two hours was paid to the Norfolk Navy Yard where the society was received with distinguished honors by the officers of the yard, who received them at the gate in full uniform, drawn up in line, and afterward devoted themselves most courteously to explaining all the interesting features of the yard and of the new war ships there building. We can hardly attempt to describe either, except to note in passing the great use which is now made of electricity as a source of portable power, and which seems to have especial convenience for ship building. The war scarred "Passaic," which bears the marks of scores of heavy shot upon her turret, excited especial attention.

The day's outing was somewhat interfered with by rain, as usual, but was thoroughly enjoyed. There were no formal proceedings in the evening.

On the morning of Thursday the business meeting was held, the only important procedures at which were the choice of the nominating committee and a discussion of the newly promulgated rules prohibiting the publication of abstracts of papers or discussions before they had appeared in the "Transactions." President Cohen first announced on behalf of the Board of Directors that while the Board did not wish to take any formal action until the publication committee had been heard from more fully, they would announce now that the new rules were suspended so far as this convention was concerned, and that the society might rely on the Board's taking such further action as the interests of the society demanded. He went on to add that so far as he was concerned he had never heard of any such proposed action, and he very distinctly implied that he strongly disapproved of it, as did most or all of the Board, and that they only refrained from completely abrogating the rules in order not to appear precipitate. With this announcement, however, he suggested that the subject had better be dropped.

A number of members plainly thought differently. Mr. Theodore Cooper stated that he had heard the announcement of the Board with pleasure, but that he felt there should be some formal expression of the views of the membership on the subject, not to embarrass or dictate to the Board of Direction, but to indicate what the feeling of the society really was on the subject. He had noticed the new rules with disapproval and regret. He felt that it was a step backward when we should rather be stepping forward. He would move simply that the convention "approve of the action of the Board of Directors in suspending the new rules as to publications," but he felt that some resolution on the subject was called for.

Mr. Wm. Metcalf seconded the resolution. He declared that the effect of the new policy would be most unfortunate. The presentation and reading of papers was the only legitimate way for an engineer to advertise himself. He had the strongest possible motives for desiring that the paper should be republished and read as widely as possible. To curtail the number of readers was simply to discourage the presentation of papers to the society.

Mr. Desmond Fitz Gerald, of the Committee, said that he strongly approved of all that had been said, and had not himself known anything about the action of the committee, but in courtesy to the Chairman of the committee (Mr. O. F. Nicols), who was not present, he thought that the resolution should not be passed.

Mr. Cooper questioned the soundness of this reason for inaction, and considered that the resolution should pass. It reflected on no one; it did not limit the discretion of the Board nor specify any future actions. There was no reason why each member should not be able to make up his own mind on the question of policy involved, and the chairman of the committee could only explain his own motives, which were not questioned.

Mr. Chas. Macdonald and others spoke earnestly in favor of the resolution, and of a broad and liberal policy in regard to publications. The opposite feeling, if it exists, was entirely unrepresented at the meeting. The resolution was passed unanimously. The only remaining business was the passage of the usual resolutions of thanks and the appointment of the seven members who, with the last five living ex-presidents, constitute the nominating committee. There was a good deal of good-natured discussion and chaff over this last process, which occupied some time but not much serious attention. The result of the ballots for nominations excited some amusement. In one district only 12 were voted, each one for a different person. Nine votes was the utmost any man had, and he was not chosen. The scattering had it, by a large majority.

In the afternoon there was a short session for the reading of papers, as also on Saturday and Monday. The following papers were read and discussed at these meetings: "Black Eagle Falls Dam," by M. S. Parker; "Bridging Canyons Lengthwise," by H.V. Hinckley; "Foundations," by A. P. Boller; "Hardening Structural Steel," by A. C. Cunningham; "Tests of Full Sized Eye Bars," by F. H. Lewis; "Experiments on Iron and Steel Joints," by B. P. Flint; "Thin Floors for Bridges," by A. F. Robinson; "Motive Power for Street Railways," by A. F. Sears; "Tests of Power Required to Drive Electric Street Cars," by L. B. Bonnett; "Construction and Cost of B. & O. R. R. Tunnel in Philadelphia," by W. W. Thayer; "Railway Emergencies," by C. M. Bolton, and "Increasing Cost of Railway Tie Renewals," by B. Reece.

On Friday afternoon a fine exhibition of target practice was made for the benefit of the society by command of Colonel Frank. The expected launch of the new iron steamer "El Norte" at the yard of the Newport News Dry Dock & Ship Building Co. did not take place. On Friday evening Mr. A. Fteley, Chief Engineer of the new Croton Aqueduct, gave an informal talk on that work accompanied by an exhibition of lantern slides. On Saturday evening the usual convention banquet took place, which was not quite so largely attended as usual, but was otherwise a very successful affair.

NEW ENGLAND WATER WORKS ASSOCIATION.—The eleventh annual meeting of the association was held at Holyoke, Mass., June 8 to 10.

The convention opened Wednesday afternoon with an address of welcome by Mr. J. F. Sullivan, Mayor of Holyoke. President H. G. Holden in his address called especial attention to the question of obtaining pure water supplies. He suggested that the annual meetings be held in a winter month, when the members have more leisure, and that they be held hereafter in Boston. Permanent headquarters, with a secretary to devote his whole time to the work, were also advocated by the president.

Secretary R. C. P. Coggeshall reported 200 active, 70 associate, and 5 honorary members. Additional members elected during the meeting swelled the membership to about 400. Treasurer Hiram Nevons reported a balance of $1,908 in the treasury.

Mr. Byron T. Cook read a paper entitled "Detecting a Waste of Water." The method employed was to shut off sections of the system until the approximate locality was ascertained.

Mr. Geo. A. Ellis, C. E., submitted a paper entitled "Two Methods of Obtaining Fire Protection by Direct High Pressure from Water-Works Pumps, in Combined Pumping or Stand-Pipe Systems."

Mr. Ellis favored direct pressure where practicable, and described two methods of turning on direct pressure in connection with stand-pipe or reservoir systems. At Racine and at Janesville, Wis., electric devices are used, but to resume the connection it is necessary to send a man to open the gate. In addition electric storms sometimes operate the device. An improvement was introduced at Marion, O., about two years ago, and was soon duplicated at Decatur, Ala.

At Marion the stand-pipe is 3¾ miles from the pumping station. The inlet and outlet pipe of the stand-pipe are the same. The device consists of a 16-in. gate, operated by hydraulic pressure. This gate is inserted in the main pipe line between an ordinary gate at the base of the stand-pipe and another gate in the street. The hydraulic gate is an ordinary Chapman bell end, hood gate, with a composition covered steel piston rod and stuffing box in place of a screw spindle. A 10-in. composition lined cast iron cylinder is connected to the hood of the gate by a yoke. All of the hydraulic work, aside from the outside body of the gate, was done by the Deane Steam Pump Co., of Holyoke.

Each end of the hydraulic cylinder is connected with corresponding ports of the operating valve by ¼-in. pipe. The intake port of this valve is connected with the 16-in. main by two lines of ¾-in. pipe, one on each side of the gate. These lines of pipe are united before reaching the operating valve, and were made double in order to utilize the pressure in the main pipe line at the end of the gate, where the pressure is greatest.

By throwing the pressure through the operating valve into the cylinder at the end nearest the gate, the gate is opened, and if the pressure is applied at the other end it closes. The exhaust passes back through two ports in the operating valve.

This valve was designed by Mr. A. H. Howland, C. E., and has a composition lined cast iron shell with an interior diameter of 2 ins. There are five ports, cast ¼ in. wide, one being for the inlet, two for operating and two connecting, one each, with the ends of the hydraulic cylinder. On a ½-in. valve stem there are three brass pistons, ⅝ ins. thick, arranged so that a ⅝-in. movement of the valve stem will divert the pressure to the operating port at one end of the cylinder and cut-off the exhaust at that end, while the same motion will shut off the pressure and connect the operating port and exhaust at the other end. The pipe used is ¾ ins., reduced to ¼ in. at the operating valve of the hydraulic cylinder. With a stand-pipe pressure of about 45 lbs. the 16-in. gate opens or closes in 45 to 50 seconds.

A 5 HP., high-speed, vertical steam engine and dynamo of the same power operate the device and light the pumping station. A lifting magnet capable of raising 200 lbs. is located at the operating valve and connected with the dynamo at the pumping station. This magnet consists of two pairs of spools, in a cast iron frame, with a rocking arm above, which carries a heavy bar of soft iron. To the top of this arm a second arm is attached and connected with the operating valve by a rod and bell-crank. A motion of ¼ in. is sufficient to bring either bar of iron into contact with its particular set of spools.

Insulated copper wire connects each pair of spools with a switch-board at the pumping station. The electric current can be applied from the station to either end of the soft iron bar attached to the rocker arm, and thus the operating valve can be manipulated to turn on or off the water from the stand-pipe.

The electrical apparatus was designed and furnished by the Thomson-Houston Co. The device has worked well. There are no patents on the combinations involved.

Wednesday evening two papers were read. The first one was by Mr. F. L. Fuller, and was a "Description

of the Water-Works at Franklin, N. H." These works were described in our issue of May 12, 1892, and the covered reservoir connected with them was shown by illustrations.

The second paper of the evening was by Mr. John R. Freeman, C. E., Boston, Mass. Its title was: "The Arrangement of Hydrants and Water Pipes for the Protection of a City Against Fire." Mr. Freeman first stated that for a good fire stream 250 gallons per minute is required. At present 2½-in. fire-hose is a standard, but the hose of the future will probably be 2¾ ins. A 1⅛-in. nozzle is now generally used, but a 1½-in. nozzle is best adapted for all-round work. About 40 to 50 lbs. makes a desirable nozzle pressure, this being limited by the skill of the firemen in handling hose.

Regarding the desirable number of fire streams available for simultaneous use for given populations, Mr. Freeman gave the following:

Population.	Number of streams.
1,000	2 to 3
5,000	4 to 8
10,000	6 to 12
20,000	8 to 15
40,000	12 to 18
60,000	15 to 22
100,000	20 to 30
200,000	30 to 50

The mains should be large enough and hydrants sufficiently numerous to allow the concentration of two-thirds of all the streams on any one valuable block. In the recent Boston fire 86 streams were used for 400,000 inhabitants.

Fire supplies regulate the sizes of mains. In domestic supplies the object is distribution, but in fire supplies concentration is desired. The total supply should equal the maximum domestic draft, plus the amount necessary for fire protection, but owing to excessive cost this cannot always be provided, and some risks must be run. New works are often tested before the domestic draft is established.

When elevated reservoirs are used, water sufficient for a six hours' fire draft should, if practicable, be provided. If reserve pumps are available, a one hour's storage may suffice.

Hydrant rentals are likely to cause hydrants to be placed too far apart. Hose will be saved and economy effected if the hydrants are placed near together, ordinarily not more than 500 ft. apart, and near important buildings, 300 ft., apart. A stiff 1¼-in. stream under 100 lbs. hydrant pressure will do effective work through 300 ft. of hose; a 1⅛-in., through 400 ft.

Generally no fire main less than 6 ins. in diameter should be used. A 4-in. main under 75 lbs. static pressure will, at the end of ½-mile, furnish only one small fire stream. By using a gridiron of pipes with 8-in. mains around the outside, and crossing through 6-in. pipes, give good service. Where very valuable property is to be protected the sizes of the pipes or of the large ones, may be increased. The main pipe need not go far into the town, but should extend toward the center of growth.

In discussing the paper Mr. Dexter Brackett said that in Boston 12-in. mains were laid about one-fourth mile apart, connecting with 8 and 10-in. pipe. In a part of the city the 12-in. mains are duplicated. In Boston 28½% of the mains are 12 ins. in diameter, or more; in New York, 24%; St. Louis, 11%; Chicago, 6½%; Cincinnati, 1½%. In Baltimore about 250 miles, or some 60% of the total mileage, is of pipe less than 6 ins. in diameter. Some of the lines, however, are duplicated.

In New York considerably over one-half of the hydrants have but one opening, and that is only 2½ ins. in diameter. In Brooklyn all of the hydrants have but one opening, 2½ ins. in diameter. In Boston the post hydrants have two 2½-in. and one 4-in. opening, and the Lowry, which are set in the center of the street, have 9-in. barrels and connections for fire-engines, two 4 and two 2½-in. openings.

Mr. Brackett had selected 14 stations in several large cities, and determined how many steamers could be massed at each station within 500 ft. of a fire.

The numbers ranged as follows: New York, 10 to 62; Boston, 25 to 60 (allowing only three streams to the Lowry hydrants, whereas four can be used); Chicago, 13 to 32; Philadelphia, 7 to 23; Baltimore, 3 to 37; St. Louis, 4 to 10; Brooklyn, 5 to 15; Detroit (nine stations), 5 to 43.

The first paper read Thursday morning was by Mr. G. A. Stacy. It described an unsuccessful attempt to devise an apparatus for forcing hydrants off pipe lines.

Mr. R. A. Robertson, Jr., C. E., read a paper on the "Venturi Water Meter." A description of this meter was given in Engineering News of Dec. 24, 1887.

Recent experiments by Mr. Clemens Herschel, C. E., the inventor of the meter, confirm the accuracy of his previous operations. A 4-ft. meter has been used at the Macopin intake of the East Jersey Water Co., at the head of the new pipe line, which is now supplying Newark.

The Venturi meter will measure 150,000,000 gallons of water per day with an error of only 0.5%. It is not accurate for very low velocities, but can be used for as low velocity as is generally found in practice. A 16-in. Venturi meter has just been made for Montclair, N. J., by the Builders' Iron Foundry, of Providence, R. I.

A device has been perfected to make a continuous record of the measurements by this meter.

The velocity of flow at the throat of the meter is determined by the excess of pressure in the pipe at a point above the contraction over the pressure at the throat of the meter. It may be added that the meter is simply a length of pipe which is contracted at one point so that it looks like two truncated cones with their small ends placed together.

Mr. W. G. Richards said that he should think the meter would be very valuable in determining the consumption of water from a gravity system.

In reply to a question from Mr. F. L. Fuller, C. E., Mr. Robertson stated that he thought a 6-in. Venturi meter could be made for about one-half the the cost of an ordinary meter, and larger sizes much cheaper, relatively. The meter is designed for measuring the flow of water through large mains, and it is not intended to bring it into competition with the ordinary meters. The Venturi meter can be used to measure gases or heavy fluids, as well as water.

At this point the nominating committee presented its report and the officers recommended for the next year were elected, as follows: President, Mr. Geo. F. Chace, Taunton, Mass.; Vice-Presidents, Messrs. Geo. E. Batchelder, Worcester, Mass.; W. E. McCallister, Calais, Me.; F. P. Webster, Lakeport, N. H.; J. L. Congdon, East Greenwich, R. I.; J. A. Butler, Portland, Me., and F. H. Crandall, Burlington, Vt.; Secretary, R. C. P. Coggeshall, New Bedford, Mass.; Treasurer, Hiram Nevons, Cambridgeport, Mass.; Senior Editor, Dexter Brackett, Boston; Junior Editor, W. H. Richards, New London, Conn.; Executive Committee, F. E. Hall, Quincy, Mass.; J. C. Tenney, Leominster, Mass.; Geo. A. Stacy, Marlboro, Mass.; Finance Committee, F. A. Anderson, Nashua, N. H.; A. R. Hathaway, Springfield, Mass.; J. L. Harrington, Cambridge, Mass.

It was voted to hold the fall meeting of the Association at Middleborough, Mass. The place and time for the next annual meeting was referred to the executive committee.

Mr. J. L. Harrington, Cambridge, next read a paper on "A Canal Siphon at Cambridge." A 12-in. main was laid beneath a canal by means of scows. Ward flexible joints were used for the horizontal part of the siphon and ordinary joints for the vertical part.

A paper by Prof. T. M. Drown entitled "The Effect of Aeration of Water and Sewage," was read by Prof. W. T. Sedgwick.

The paper stated that it had been held by some that the aeration of water purifies it through oxidation. Two years' experiments by Prof. Drown have shown this is not the case. Aeration, however, does remove odors from water, and, by agitation, prevents the growth of algae or the stagnation of water. It also removes iron in the form of protoxide. Oxidation is not hastened by aeration.

The paper was an important one and more will be said regarding it in a later issue.

The closing paper was by Prof. W. T. Sedgwick, and was entitled "The Purification of Drinking Water by Sand Filtration; its Theory, Practice and Results, with Especial Reference to American Needs and European Experience." The paper was illustrated by stereopticon views.

The author stated that the belief that polluted water purifies itself largely accounts for the many bad water supplies in the United States. Self-purification of water is only a half-truth.

The principal methods of improving the quality of of water are sedimentation, storage and filtration. Storage gives time for sedimentation and for the germs in the water to die. Sedimentation carries impurities to the bottom, where bacteria are likely to die. Sand filtration is the best method of removing impurities from water. The water before filtration, however, should be as good as possible and the first water that passes through a new or newly prepared filter bed should not be used.

The method of sand filtration employed at the large German city of Berlin was described and illustrated in detail. Here there are, from the bottom upward, first clay, then in order, beton, stone, gravel and finally 18 to 24 ins. of sand. Before filtration is started water stands upon the sand until a gelatinous micro membrane about as deep as a thick sheet of paper is formed. This membrane really does the filtering, the sand performing only a secondary part. An epidemic of typhoid fever followed a period of too rapid filtration. Water is taken from the river Spree and from a lake, but both supplies are filtered. The river plant was described.

The filter beds are cleaned at intervals of from five days to two months, depending upon the season and circumstances. A thin, green deposit is scraped from the surface. The sand below is found to be bright and clean. The sand taken off is carefully washed in a special apparatus and afterward replaced.

At Rotterdam, also a European city, the membrane described above is not used and the results are far inferior to those at Berlin.

At London, England, the water is filtered with great care, and in addition care is taken to prevent pollution of the supply. In at least one week last winter as many deaths from typhoid fever occurred in Lowell, Mass., with its 80,000 inhabitants, as in London, with its population of 5,500,000. The death-rate from typhoid fever in London is as low as that of any large city in the world. (See diagram and statistics showing typhoid fever in London, New York, Chicago, Philadelphia and Boston, since 1869, Eng. News, April 21, 1892.)

What are American cities doing to supply themselves with pure water? Chicago drinks from her own cesspool. Philadelphia uses water from highly polluted rivers. Albany drinks sewage from the cities above it. Lowell takes the sewage of the cities above it in its water supply and adds its own sewage from 80,000 people for Lawrence to drink.

In discussing the paper Mr. F. P. Stearns remarked that testimony is growing to the effect that water must not be taken from sewage polluted streams. Efforts should be made to improve waters not subject to such pollution, as some of them need improvement.

Mr. Allen Hazen compared the number of people killed at grade crossings in Chicago in 1891, which he gave as 600, with the 2,000 deaths from typhoid fever in the same year.

Of the six topics for general discussion given on the program there was time to take up but the first two, "The Proper Coating of Cast Iron Pipe," and "Is it Desirable to Have Water Pipe Cast with the Bell End Down?" No conclusions were arrived at. The well known preparation of Dr. Angus Smith was highly approved by some and others thought asphalt fully as good, if not better. Mr. Dexter Brackett thought that sufficient care was not always taken in coating the pipe. If a spot no larger than a pinhead is left tubercles may form. A double coating would go far toward making a thorough job.

Regarding casting pipe with the bell-end down it was urged that it is desirable, as this end is the most important and covers or partially covers any defects in the other end. Boston specifications call for casting with the bell-end down. It was held, on the other hand, that the bell-end, being the heaviest, it can be inferior with less risk than could the other end.

The proposed excursion to Mount Holyoke on Thursday afternoon was postponed, on account of the weather, to Friday afternoon. On Friday morning the Holyoke Water Commissioners escorted the members and guests to the reservoirs connected with the city water supply, of which there are three, filled from surface water.

During the convention the following were elected as resident active members: W. E. Rawson, Uxbridge, Mass.; L. C. Wright, Northampton, Mass.; J. B. Rider, South Norwalk, Conn.; Robt. J. Thomas, Lowell, Mass.; S. G. Stoddard, Jr., Bridgeport, Conn.; Geo. K. Crandall, New London, Conn.; B. R. Felton, Marlboro, Mass.; Allen Hazen, Lawrence, Mass.; C. L. Knapp, Lowell, Mass.; T. W. Mann, Holyoke, Mass.; W. F. Cleveland and E. H. Reynolds, Brockton, Mass.

The following were elected as non-resident active members: H. F. Doran, Port Huron, Mich.; G. H. Benzenberg, Milwaukee, Wis.; E. L. Dunbar, Bay City, Mich.; Jas. F. Haring, Fort Madison, Ia.; John Ervin, Bridgetown, N. J.; D. W. French, Weehawken, N. J.; Wm. R. Hill, Syracuse, N. Y.; J. L. Kuehn, York, Pa.; R. G. E. Leekie, Middleton, N. S.; T. H. McLaughlin, Texarkana, Ark.; Geo. W. Wright, Norfolk, Va.; J. W. Ridpath, Jenkintown, Pa.; G. H. Robertson, Yarmouth, N. S.; L. J. Wagner, Rome, Ga.; John Mansur, Brooklyn, N. Y.; E. L. Abbott, New York.

Associate members were elected as follows: Meter Register Co., Chicago, Ill.; G. H. Moore, Norwich, Conn.; Hydraulic Construction Co., New York; Crosby Steam Gage & Valve Co., Boston.

There was a very good exhibit of water-works appliances made by the associate members. The exhibitors were as follows:

Walworth Manufacturing Co., Boston, tools and supplies, including the Hall tapping-machine; Hydraulic Construction Co., New York, driven and similar wells; George Richardson, Bridgeport, Conn., castings on pipe for tapping; Illinois Malleable Iron Co., Chicago, stopcock box; Thompson Meter Co., New York; National Meter Co., New York; Hersey Meter Co., Boston; Union Meter Co., Worcester; Chicago Meter Register Co.; Chapman Valve Co., Indian Orchard, Mass.; Michigan Brass & Iron Co., Detroit; R. D. Wood & Co., Philadelphia; Holyoke Hydrant & Iron Works, Holyoke, Mass.; The Fairbanks Co., Boston; The Ross Valve Co., Troy; Deane Steam Pump Co., Holyoke, Mass.; Crosby Steam Gage & Valve Co., Boston; Philip Ely, Bayonne, N. J., tapping-machine; A. P. Smith, Newark, N. J., tapping-

machine; Taunton Locomotive Works, Taunton, Mass., tools; Perrin, Simmons & Co., tools; Moore Filter Co., Holyoke, Mass.

MASTER CAR BUILDERS' ASSOCIATION.—The 26th annual convention of this association began on Wednesday, June 15, at Saratoga, N. Y. The following are the reports of the various committees of the association presented at the meeting:

A full report of the proceedings will be given in our next issue.

AIR BRAKE AND SIGNAL INSTRUCTIONS.

The committee to which was referred the standard code of rules for the instruction of employees in the use of the airbrake and train signal have made a number of changes in accordance with the recommendations of the various railway clubs. The rule which has caused most discussion, however, on the adjustment of the brake-piston travel to not less than 4 or not more than 8 ins., has not been altered by the committee. Concerning this they say:

There may be said to be two principal objections to this rule: one is, that if inspectors are allowed in making adjustment to take up the slack so closely upon any cars that the piston will travel but 4 ins., the conditions may be such that in the same train there may be brakes having a piston travel of but 4 ins., and others having a piston travel of nearly 12 ins., and it is well known that the piston pressures in such cases will vary considerably. As the auxiliary reservoir pressure is the same as the piston pressure under a full application of the brakes, the auxiliary reservoir pressures will therefore vary considerably where some pistons travel but 4 ins. and others 12, and, therefore, some brakes will be more difficult to release than others. This criticism is recognized by the committee to be entirely valid, and has been given careful weight.

The other objection is, that in cases where the brakes are hung low and suspended from the truck bolster, or from the car body, the adjustment of the brake gear might be made upon a loaded car and the piston travel reduced to 4 ins. The unloading of such a car and the consequent raising of the bolster on the springs before the shoes have become much worn, would be liable to cause the brakes to drag upon the wheels constantly. In regard to this criticism your Committee has but one reply to make, which is, that it is now so generally recognized that these methods of hanging the brakes are bad ones, and they are being so generally abandoned that this criticism should have but little weight.

On the other hand, in favor of the 4-in. limit, is the consideration that freight trains generally are required to run long distances, with no opportunity for adjustment of brakeshoe slack in the interval. Upon railroads, where long runs over an undulating country are necessary, it is of the highest importance that an adjustment of the piston travel should be made in the outset, which will permit the brakes to remain effective through the whole run. We are assured by those who have had experience in hauling air braked freight trains for some years, over their roads, that an adjustment of the piston travel to only 6 ins. would not render the brakes serviceable throughout the runs.

Your committee has given full consideration to these various views of the question, and, in the face of such testimony as has been presented, we do not feel warranted in altering the recommendation of the committee of last year. If any alteration had been made by this committee, it would have been to reduce the 8 in. limit to 7 ins., and we believe that this would be an advantageous change. Since, however, the brake beams and the brake gear upon a great many freight cars are so light that an adjustment of less than 8 ins. would tend to cause the shoes to drag upon the wheels when the brakes are released, we did not feel warranted in recommending the change.

The committee emphasize previous recommendations concerning the use of a metallic brake beam and the observance of the standards for brake gear adopted by the association.

E. W. Grieves, R. D. Wade, J. L. Greatsinger, committee.

CAST IRON WHEELS.

The committee on this subject reported that their circular letter had been answered by 16 railways and 13 wheelmakers. The following are the questions asked and the information obtained:

1. Do you use what is known as the "contracting chill" in the manufacture of cast iron car wheels, and if so, what percentage of your product is made in such chills and whose design of contracting chill do you use?

Of the 16 railways, 11 use the contracting chill, 2 the plain chill, and 3 did not reply. Of those using the contracting chill, 1 uses the Canda, one the Whitney and 9 the Barr. Of the 13 wheelmakers, 5 are using or arranging to use the Barr chill, 1 the Whitney, 1 the non-expansive chill and 5 the plain chill. This gives a total of both railways and wheelmakers of 14 using the Barr chill, 2 the Whitney, 1 the Canda, 1 the non-expansive and 7 the plain chill.

2. Do your foundry or service records show that there is any advantage in using the contracting chill which is not had with the older form of fixed chills, either in percentage of loss, or uniformity and quality of product?

Those using the contracting chill and its products agree (with one exception) that foundry loss is decreased. Some place it as high as 50%. The one exception is a road that was noted for its success with cast iron wheels before the introduction of contracting chills. It is the opinion of the committee that the evidence at hand goes to prove an advantage in this respect. As regards uniformity and quality of product, nothing can be said by the committee.

3. Do you find that cheaper grades of iron may be used in wheels made in the contracting chill with as good results as more expensive grades of iron in solid chills?

Of the 29 who answered the circular, only 3 said that cheaper iron might be used. Of the others, 1 was doubtful, 2 had no data, 7 though it not advisable, 5 replied no, and 11 made no answer. From these answers and from data furnished by an advocate of the chill, who has made elaborate experiments, the committee conclude that it is not advisable to use a lower percentage of new iron for wheels made in contracting chills, than for those made in plain chills.

4. What percentages of new iron do you find it desirable to use in making wheels in the contracting chill and in the plain chill?

The replies of the advocates of the contracting chill vary from 30 to 75% for the proportion of new iron. Only two advocates of the plain chill replied, one of whom specified 45 to 65% of new iron and the other 50%. The committee thinks that not less than 50% of new iron should be used, whatever the chill.

5. Has the percentage of guaranteed wheels which you have been required to replace, or have replaced, been modified by the use of the contracting chill in the manufacture of such guaranteed wheels, and to what extent?

Of the 29 answers, 20 expressed no opinion or had no data, or lacked experience; 3 replied that there was no difference, and 6 reported a decided improvement. One maker has reduced the failures which were guaranteed against from 0.16% to 0.019%. It is evident, however, that users of cast iron wheels have not yet had experience enough to warrant a very general reply to this question.

6. Do you grind or balance wheels before you ship them to the purchaser, or before you put them in service?

Of the 29 who answered the letter, 17 grind all or a part of their wheels, 4 neither grind nor balance, and 8 did not reply. The committee regrets that this question was not more generally and fully answered, as upon it, in their opinion, exists about the only difference of any importance between the advocates of the contracting chill and the plain.

7. In case you grind or balance your wheels, has the percentage of wheels which you have been required to replace or have replaced, been reduced by the grinding or balancing below what it was for wheels made in the same form of chill before they were ground or balanced, and to what extent?

All parties answer that they have no data and not enough experience to answer this.

8. What is your wheel guarantee?

The general guarantee appears to be four or five years in freight service and 60,000 miles in passenger service. A notable feature of the report is that parties advocating 25 to 40% of new iron only guarantee their wheels for 3 years in freight service, while those using 75% of new iron guarantee their wheels for 5 years in freight service or 70,000 miles in passenger service.

9. What variations are allowed in weight and in circumference of wheels of the same nominal weight or diameter?

Seven made no reply to this; and of the 18 who answered, 8 allow 2% in weight and ¼ in. in circumference; 2 allow 15 lbs. in a 580-lb. wheel and 1-16 to ⅛ in. in diameter; 3 allow 20 lbs. in weight; 2 allow 10 lbs.; 1 allows 5 lbs., and 1 has no specifications. From the wide variation the committee conclude that all did not understand this question alike.

10. How long are wheels permitted to remain in the annealing pits?

The answers are somewhat surprising, as they vary from 3 to 9 days. The committee thinks that greater uniformity in practice would be of advantage, for if 3 days suffice for proper annealing, allowing the wheel to remain 6 to 9 days must be needlessly expensive, the plain or the contracting chill, and it appears to be a question of opinion or circumstances.

11. What do you consider the proper depth and distribution of the chill on a wheel?

It appears from the replies to be generally considered that a model wheel should have a ⅝ in. chill. The practice varies, however, from ⅝ in to ¼ in. on the tread and from ¼ to ⅜ in the throat.

Besides the replies to the circular the committee has obtained statements from Messrs. Barr, Whitney and Faught as advocates of the contracting chill and from Messrs. Griffin and Lobdell as advocates of the plain chill. Some points made by the former are as follows:

One of the largest makers and users of wheels says he expects decided gains by the use of the contracting chill, as wheels may be ground with safety, after being slid flat and used again, on account of the extra deep chill. Another says 4½% of wheels cast in plain chill were condemned on account of chill cracks and other defects not known in the contracting chill.

One wheel manufacturer says wheels cast in contracting chill do not vary ¼ in. in circumference, another says ⅝ in., another says: "Without hardening our mixture we obtain, in at least 90 % of our wheels, a chill ⅝ to ½ in. deep, uniformly all around the wheel at the root of the flange, while the same mixture if cast in the solid chill would have no chill at all or it would be very slight." It is said that specific gravity tests of white iron produced in the contracting chill, show from 1 to 3 lbs. greater weight per cubic foot than the same iron from the plain chill.

One of the plain chill advocates makes a very forcible remark and one worthy of consideration, namely, "that the contracting chill is a much heavier one than the plain chill of five or eight years ago." His experience, which is large, confirms his belief that the plain chill of same weight as the contracting chill, and the same material in the hands of skillful and experienced men, will produce equally as good results as the contracting chill. This is also confirmed by two other large manufacturers, who have verified statements that this experiment has been made to their entire satisfaction, and who further claim that the time between pouring and chilling the iron is very little affected by any contracting chill, and conclude by saying: "If railroads will first specify everything possible, so they can upon inspection: 1. Be sure of a safe wheel; 2, see that it will indicate sufficient chill; 3, find that it is mechanically correct and not liable to damage from rough riding, flange wear, etc., and ask the makers to guarantee certain mileage, and let them (the makers) provide the wheel, the railroads certainly would be getting all they could ask for."

In conclusion the committee expresses briefly the opinion, that the experiments made and being made in the distribution of metal by those connected with roads which have facilities for making experiments, places the members of our body under obligations to them; and wheelmakers are entitled to more credit than they now receive for the production of a cast iron wheel weighing less than 600 lbs. guaranteed to carry our largely increased loads, running 40 to 50 miles per hour for 60,000 miles, at a cost far below the price we pay for other parts of our car and locomotive castings. When we consider the remarkable progress in the manufacture of cast iron wheels, and how well the makers of such wheels have kept to the front in the "wheel procession," we must admit that they are entitled to a large amount of credit.

Geo. W. West, W. H. Thomas, John Player, committee.

FREIGHT CAR TRUCK FRAMES.

The committee appointed to examine into the relative merits of the swing and rigid bolster trucks, and of the Fox steel pressed truck and the diamond truck for 60,000-pound cars now in use, reported as follows:

We received 43 replies to our circulars, 33 of which favored the rigid over the swing bolster type of truck; 15 of the 33 were using the Fox steel pressed truck under from 1 to 15 cars each, and so far they had given entire satisfaction. One member had one car with this truck in constant service for 15 months, and there had been no expense for repairs.

All said that the Fox truck possessed good points, but that it had not been long enough in use for any one to recommend it. In view of these facts, the committee recommend that this work be carried to the succeeding year, as the time required to ascertain the merits and faults of the Fox solid steel pressed truck will be considerably more than one year.

Geo. F. Wilson, W. S. Morris, S. A. Crone, committee.

M. C. B. AUTOMATIC COUPLER STANDARDS AND LIMITS.

The committee recommended the gages proposed in the announcement of September, 1891 (Eng. News, Sept. 19, 1891), with the limits of variation then announced. It has been ascertained that these limits are sufficient to cause no difficulty in the manufacture of the couplers. Of the rectilinear measurements then recommended, the committee calls special attention to the width and depth of the shanks immediately behind the head of the coupler, and the advisability of increasing the width. The committee finds that the most serious failure of couplers takes place in the guard arm. Increasing the width at this point will admit of strengthening the guard arm, and will also provide additional strength to prevent it pulling off the head of the coupler. A failure of this kind usually permits the head of the coupler to fall upon the track, with occasional disastrous results. Various devices have been adopted to prevent the coupler from falling upon the track in case of the failure of the end fastening, but no means has as yet been provided, so far as the committee knows, to prevent the head from falling upon the track when it becomes broken from the shank of the coupler. The committee further recommended the adoption of a standard method by the association for operating the locking devices of the M. C. B. couplers. Also the adoption of a more secure fastening than the tail bolt for automatic couplers; the "U" shaped, or pocket, fastening, said the committee, seems to offer a very much more secure and efficient device for this purpose.

The committee stated further that they had concluded the formulation of standard tests for M. C. B. couplers to be within their duties. They, therefore, submitted a provisional code of tests (published in "Eng. News of April 28, p 436), and stated that in addition guard arm tests, a drop test to represent the shock to which couplers are subjected in pulling, and tests to determine the resistance of the coupler to distortion within the limits of the gages were under consideration. The committee ad-

vised that no action be taken on these tests at the present meeting, but that they be accepted provisionally, and that final action be taken one year hence, also that the Executive Committee consider the advisability of calling for a general laboratory test of all the established makes of coupler sometime during October or November. By application through the proper channels the tests might be made at the Watertown arsenal.

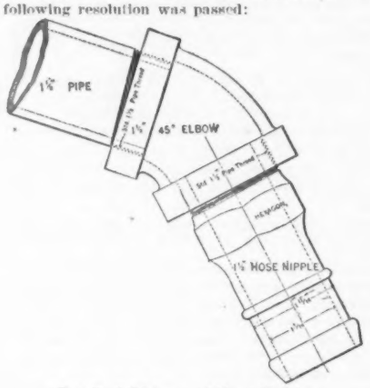
J. S Lentz, G. W. Rhodes, J. M. Wallis, Committee.

STEAM HEATING AND VENTILATION OF PASSENGER CARS.

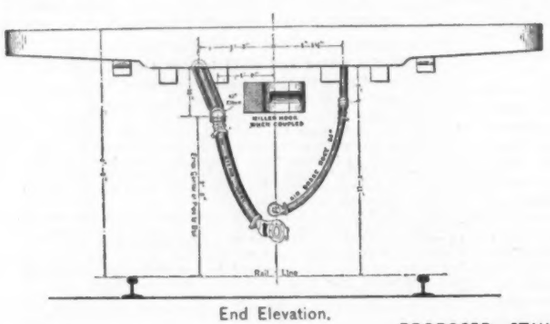
The committee in the report stated that little advance had been made during the past year in car heating methods, but there had been a decided advance in the number of cars equipped. The committee noted also "a tendency during the past year to eliminate complications and refinements of design based on theoretical considerations. For example, a temperature regulator has been abandoned on several large lines, not because the device is not desirable, nor because it did not perform its work satisfactorily when in order, but because better results were obtained by making uniformity of temperature dependent on the attention of the trainmen." So also the plan of cutting off part of the radiating surface of the pipes in the car in mild weather has been abandoned in some cases, not because the arrangement when in working order did not give very satisfactory results, but because the complication produced by the additional valves, etc., necessary to accomplish the results were found more objectionable than the advantages gained by their use.

Concerning the direct steam and the indirect, or hot water, systems of heating, the committee say that the direct steam is the cheaper and simpler, but is not susceptible of as fine regulation as the indirect. It is generally recognized to-day that the other method is the proper one for heating sleepers by steam.

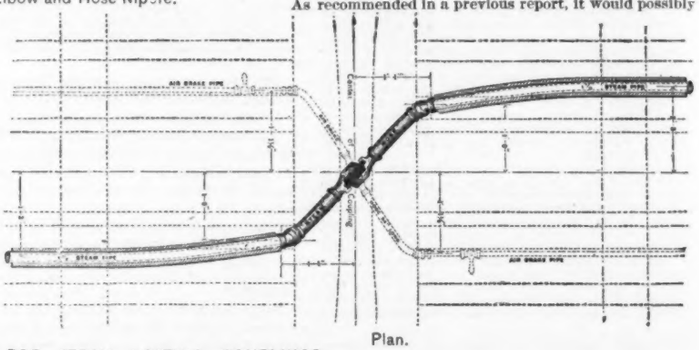
In conclusion, the committee recommend that standards be adopted for the location and size of end of steam pipe, for 45° elbow on end of steam pipe, and for hose nipple and steam hose, as shown in the accompanying cuts. The standard fitting for the end of steam pipes adopted by the association last year is not in use anywhere, so far as the committee knows, and its formal abandonment is therefore recommended. J. N. Barr, J. C. Barber, W. H. Lewis, T. A. Bissell, J. W. Marden, Committee.



Detail of Elbow and Hose Nipple.



End Elevation.



Plan.

PROPOSED STANDARDS FOR STEAM HEATING COUPLINGS.

STEEL-TIRED CAR WHEELS.

The committee regretted that, on account of its inability to get sufficiently definite information, either from members of the Association or manufacturers of steel-tired wheels, it was unable to submit any data that could be considered conclusive. Many of the representative members of the Association and also several of the large manufacturers of steel-tired wheels made no reply to circulars of inquiry.

Returns received from 28 lines representing 12,423 passenger equipment cars of the 30,650, given by Poor as the total equipment in the United States and Canada in 1891, show that they have used, approximately, the following steel-tired wheels:

Type of center.	Make.	Number of wheels.
Bolted centers	Allen	14,618
	Allston	16
	Botes	2,487
	Krupp	260
	Paige	1,876
	Snow	1,234
	Total	20,491
Solid wrought spoke	Arbel	404
	Brunswick	1,354
	Krupp	80
	Total	1,838
Solid wrought disk	Krupp	924
	Total	924
Solid cast	Snow (Boltless)	80
	Washburn	1,673
	Total	1,753
	Grand total	25,006

Defects of centers were reported in tangible shape in only a few instances; the most of the defects given related to the tires and not to the centers. It would seem that the records kept by many do not enable them to trace the latter accurately. The information before the committee, however, showed that none of the bolted centers reported were entirely exempt from trouble with loose bolts.

The maximum variation in weights of the different types of centers is about 200 lbs. for wheels 33 ins. in diameter; the solid wrought spoke centers being the lightest and the solid cast centers the heaviest, the bolted centers and the solid wrought disk centers varying between these two.

R. E. Marshall, C. H. Cory, J. O. Pattee, Committee.

WHEEL GUARANTEE.

The committee, appointed to confer with the Association of Cast Iron Chilled Wheel Makers in the matter of specifications and guarantee for cast iron wheels, presented the following report:

A meeting was held on April 6, 1892, at Chicago, of the Executive Committee of that Association in which the following resolution was passed:

Resolved, "That when wheels are removed from service, for failure from any cause whatever, where there is a doubt as to whether the wheel maker is responsible or not for the failure, if it is practicable, such wheels shall be tested by the Master Car Builder, or his representative, and if it is found that the depth and character of the chill, and the strength and character of the metal in the plates, are up to the standard specifications adopted by the Joint Conference Committee of the American Railway Master Mechanics, Master Car Builders and the Wheelmakers' Association, it shall be considered that failure is due to the service and not the quality of the wheel, and that the wheel maker ought not to be called upon in such cases to pay for or replace any such wheels."

Your committee feels that the resolution as passed is indefinite in its character, and is somewhat one-sided in favor of the wheel maker.

In the first place the clause, "where there is a doubt as to whether the wheel maker is responsible or not for the failure," is extremely indefinite. Rule No. 3 of the M. C. B. Rules of Interchange reads as follows:

When wheels are renewed, they shall be treated as follows:

Wheels shall be charged to the company owning the car, if the cause of removal is: (a) Shelled out spots. (b) Seams. (c) Worn through chill. (d) Worn flange. (e) Tread worn hollow. (f) Burst. (g) Broken flange, if the breakage is caused by seams worn through chill or worn flange. (h) Broken rim, if caused by rim being hollow. (i) Cracked tread, if caused by being worn through chill. (j) Cracked plate. (k) Cracked brackets. (l) Broken in pieces. (m) Loose. (n) Out of gage.

Wheels shall not be charged to the company owning the car if the cause of removal is: (a) Flat sliding. (b) Chipped flange. (c) Broken flange if the breakage is not caused by seams, worn through chill, or worn flange. (d) Broken or chipped rim, not caused by rim being hollow. (e) Breakage of any kind caused by derailment.

This rule clearly specifies the defects for which the owner is responsible, or the user is responsible, as between railroads. All the defects common to wheels are enumerated here, with the exception, perhaps, of wheels failing on account of being "comby," and the defects as mentioned are carefully defined under Rule No. 3, Sections (a) to (m) inclusive. The defect called "comby" is of rather rare occurrence, being an irregular spot caused by collection of dirt or slag in the tread of the wheel.

With reference to the defects enumerated above, the wheelmaker certainly is not responsible for wheels "loose" or "out of gage," although the railroad company mounting and using the wheels should be responsible.

There might also be a question as to the responsibility of the wheelmaker for "burst wheels," as the bursting may have been caused by undue pressure in mounting on the axle or from bad fitting. In the case of "burst wheels" the breakage of the wheel in question and the inspection of the strength and character of the metal in the plates might be a basis for an expert to determine the responsibility of the wheelmaker, but it would be a somewhat difficult matter for Master Car Builders to determine this question satisfactorily to themselves and to the maker.

With reference to the defects, "shelled out," "comby," "seams," "worn flange," "tread worn hollow," an inspection of the "depth and character of the chill, and the strength and character of the metal in the plates" would throw no light whatever upon the subject, as there is no relation between these defects and the points referred to by the Wheelmakers' Association.

The remaining defects, mentioned in clauses from "g" to "l" inclusive, are all cases of fracture, and it is the opinion of your committee that wheelmakers should, under no circumstances, be relieved from responsibility for any of the cases of breakage referred to therein.

In the matter of worn flanges, there is a serious question as to whether wheelmakers should be held responsible for all cases of failure from this cause, as a portion of such failures may be due to trucks out of shape and improper fitting; at the same time the result of our observations would seem to indicate very decidedly that the formation of worn flanges is due to a very great extent to difference in the wearing quality of the two wheels.

As recommended in a previous report, it would possibly be fair to hold wheelmakers responsible for half of the failures from worn flanges. The members of the Wheelmakers' Association presented quite a number of examples of wheels which were considered subject to replacement by the railroad company, in which the defect consisted of "rough spots caused by sliding," and it would seem from their testimony that a great many railroads do not distinguish between "rough spots formed by sliding" and "shelled out" or "comby" wheels. This certainly is not fair to the wheelmaker, as the wheel is ruined by sliding and would have been a perfectly serviceable wheel if not unfairly treated by the railroad company in this respect. Sliding a wheel frequently heats it to such an extent as to crack the brittle white iron, causing small pieces to flake off, and this seems to be more frequently the case in well chilled wheels than in poor ones, the white iron possibly being harder. In the opinion of your committee wheelmakers should certainly not be held responsible for this defect.

In conclusion, it is the opinion of your committee that the resolution adopted by the Association of Chilled Cast Iron Wheelmakers cannot be incorporated in the specifications adopted by this Association, and that the only points which the committee has to recommend for the consideration of the Association, so far as changing the present specifications is concerned, is whether any allowance should be made to the wheelmaker for "worn flanges." As to the wheelmaker's responsibility for wheels sliding: when the sliding causes a "flaking out" on the tread, generally known as "comby from sliding," it would be impossible to incorporate this in the specifications, the matter being a question of judgment as to the cause of the spot so failing. It would possibly make the matter more definite to change the term "flat by sliding" as used in the guarantee, to "flat by sliding or comby by sliding."

J. J. Hennessey, Thomas Sutherland, Committee.

STANDARD CENTER-PLATES AND STAKE-POCKETS.

The standards reported by this committee are shown in the accompanying engravings. Four stake pockets were recommended, two sizes for single U bolts and two sizes for double U bolts. The width was made uniformly 3½ ins., and the taper in all cases is ¼ in. in 6 ins. The widths at the top are 4 ins. and 5 ins. with each style of fastening. Fig. 3 shows the proposed standard center plate of pressed steel, with dimensions given for either iron bolster or wood bolster. Some difference of opinion developed as to whether center plates should have flanges to fit the bolster. It was decided not to show them and to leave members to add them if they chose. The malleable center plates in Fig. 4 are interchangeable with the pressed steel center plates, Fig. 3.

Tests of the strength of malleable center plates corresponding in design and dimensions to those shown in Fig. 4 were made by R. W. Hunt & Co. The plates were placed between two solid blocks, 5 × 15 × 24 ins., with countersunk holes to receive the horses, which fitted

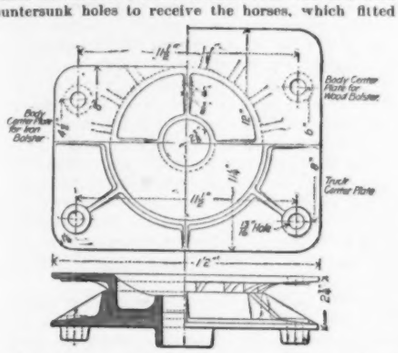


Fig. 5 Proposed Standard Center Plate of Malleable Iron.

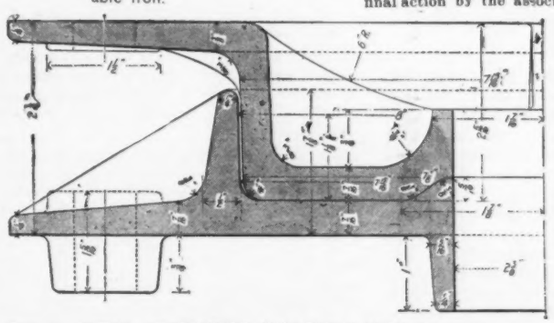


FIG. 6. DETAIL SECTION OF MALLEABLE IRON CENTER PLATE.

closely to them. The castings began to fail at a load of 163,000 lbs.

The following table gives the result of tensile tests of specimens of malleable iron made by the National Malleable Castings Co. The tests were made for that company. The main object of the table is to show the decrease in strength per square inch as the casting is made thicker, the decarbonizing and toughening of the metal penetrating but a short distance below the surface. The very small percentage of elongation is also noteworthy.

Tensile Tests of Specimens of Malleable Iron.

Dimensions of test piece. Thick, ins.	Width, ins.	Area, sq. ins.	Elastic limit. Lbs. per sq. in.	Ultimate strength. Lbs. per sq. in.	P. c. elong. in 8 ins.
.271	2.81	.7615	23,520	32,620	1.5
.293	2.78	.8145	22,650	28,160	.6
.287	2.73	.7987	21,820	28,390	1.
.39	2.82	1.098	20,595	32,160	1.5
.41	2.79	1.144	20,230	28 850	1.
.392	2.76	1.082	22,190	29,670	1.
.529	2.76	1.46	19,520	27,875	1.1
.528	2.78	1.468	18,430	27,150	1.
.512	2.78	1.423	22,150	28,100	1 2
.661	2.81	1 857	18,840	25,700	.7
.675	2.73	1.843	18,065	25,130	.7
.647	2.82	1.825	18,010	27,700	.8
.775	2.77	2.147	15,950	26,480	1.1
.8	2.76	2.208	18,200	25,120	1.1
.775	2.82	2.185	18,780	25,030	1.
1.025	2.82	2.890	18,220	28,770	1.5
1.117	2.81	3,138	17,050	25,510	1.3
1.021	2.82	2.879	18,410	26,950	1.3
Averages			19,492	27,787	

Wm. Forsyth, John Mackenzie, E. D. Bronner, Committee.

STANDARDS OF EFFICIENCY FOR AIR BRAKES.

The work done by this committee has been previously outlined in Engineering News of April 2 and 28, 1892. The committee presents a provisional schedule of tests practically the same as that already published. The following are the only changes (See Eng. News, April 28, p. 423). In the graduating test the first reduction of train-pipe pressure is made 8 lbs. instead of 16 lbs. In (4), "Tests to Determine the Sensitiveness of the Emergency Valve," the air is to be discharged through an opening in the engineer's valve of ⅜ in. In (6), "Release Test," the instructions are as follows:

A uniform pressure of 70 lbs. having been secured in

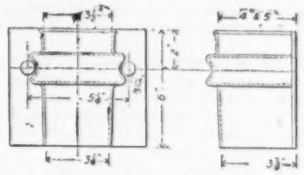


Fig. 1. Stake Pocket With One U-Bolt.

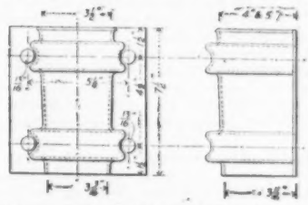


Fig. 2. Stake Pocket With Two U-Bolts.

the train pipe, all the air will be exhausted by an emergency application. A pressure of 90 lbs. will then be maintained against a diaphragm perforated by a ⅜ in. hole, and a record taken of all brakes that release inside 30 minutes. In making this test special care must be taken to see that there is no leak in the train pipe.

Under (7), "Test to Determine the Time of Charging One Auxiliary Reservoir," it is stated that the time should not exceed 60 seconds nor be less than 45 seconds. Under "Train Tests" it is recommended that tests to determine the shock should be made on a level track with all the slack in the train pulled out at the time the brakes are applied.

The committee presents the schedule of tests, not for final action by the association, but as an outline to be improved upon during the coming year. We quote as follows from the report:

Developments in power brakes for freight train service during the past year have again brought the subject of train brakes prominently before the railroads of this country. In 1887, as well as in 1886, the results of the brakes tested were such that they made specific recommendations impracticable, and even the following year, with every indication of one successful air brake in the field, any definite recommendation would hardly have been wise even if in keeping with the constitution of the M. C. B. Association. Sufficient progress has been made in the art to materially alter these conditions. With the strong competition now prevailing in transportation, and the reduced profits in the business, there not only is but will in the future be a strong temptation to railroads and individual car owners to use devices which an intelligent investigation would condemn. The M. C. B. Association can aid very materially in providing against such difficulties by establishing standards of efficiency to which the devices shall be subjected before they obtain the official approval of the Association. On the brake question the tests made at Burlington in 1886 and 1887 have effectually kept out of railway service a class of brakes known as independent or buffer brakes. During the tests, however, it developed that there were air brakes which were just as impracticable as independent brakes, and yet at the present time everything under the name of "air brake" is accepted as a safety appliance. To show that this matter may become in the future quite a serious one, it is only necessary to state that at the present time your committee is in correspondence with nine different air-brake companies, and that in several instances these represent more than one style of triple. The brake question has always been a complex one, and it is difficult for those best posted in the matter to draw accurate conclusions unless the devices are tested on a rack under identical conditions or in actual service. Air brakes have been put on the market and sold which lack some of the most essential features of an effective brake. As a matter of fact, manufacturers have not only deceived themselves but deceived their patrons, and this notwithstanding the closest investigation having been made by all parties. The best experts in the country have been unable to detect from an examination of models and drawings whether essential features, such as quick action, graduation, etc., existed or did not exist. Public opinion and general knowledge of the subject will effectively keep out the further introduction of independent brakes which were making such headway prior to your 1886 and 1887 investigation. There is, however, no board of censorship or test to keep out impracticable air brakes, or to establish which of the new devices are really meritorious. It would seem a fitting time, then, for the Association to be considering a series of requirements which shall be exacted from all air brakes prior to their receiving the indorsement of the Association. . . . . Your Committee realizes fully the importance of having nothing but the most searching requirements, nor have they lost sight of the fact that in future there will be competition in brakes. Under such circumstances the Association must fully consider whether it is not its duty to prescribe the most exacting requirements now attainable by any brake company, even to that of working successfully on a 100 car train.

In following out these investigations your committee has met with much encouragement from members of the Committee on Safety Appliances of the American Railway Association and has been in conference with its members about facilities for conducting tests. An essential feature of this work is a permanent location for carrying on the investigation with pipe rack, gages, recording apparatus, competent assistants, etc. Several of the brake companies have very considerately placed at the disposal of the committee their racks. The committee, however, is glad to announce that the Pennsylvania R. R. Co. has offered to establish for the association, at its Altoona shops, a complete set of brake testing apparatus and to give every facility for furthering these investigations. This secures for your association everything that any organization would desire, and when fully established will, without doubt, confer lasting benefits on the railroads of this country.

While what has been outlined is a departure from the usual course pursued by railroads, we believe it is warranted under the national and state legislation now going on, for such action will certainly have a tendency to

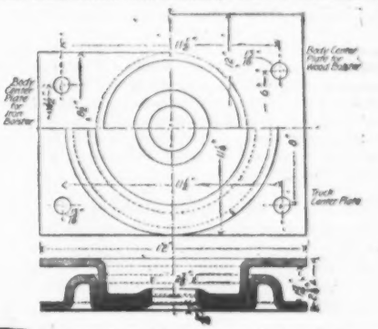


Fig. 3. Proposed Standard Center Plate of Pressed Steel.

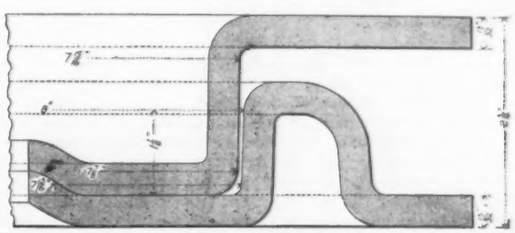


FIG. 4. DETAIL SECTION OF PRESSED STEEL CENTER PLATE.

foster and encourage spurious and useless devices. Congress will not trouble itself about keeping inefficient devices out of railroad service, and it would therefore seem wise that railroad companies should protect themselves by a departure such as your committee has outlined.

Godfrey W. Rhodes, Edward B. Wall, George Gibbs Committee.

COMING TECHNICAL MEETINGS.

MONTANA SOCIETY OF CIVIL ENGINEERS.
June 18. Secy., F. D. Jones, Helena.

ENGINEERS' CLUB OF PHILADELPHIA.
June 18, 1122 Girard St. Secy., J. C. Trautwine.

AMERICAN RAILWAY MASTER MECHANICS' ASSOC'N.
June 20. Saratoga, N. Y. Secy., A. Sinclair, New York.

WESTERN RAILWAY CLUB.
June 21. Rookery Building, Chicago. Secy., W. H. Marshall.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
June 21. Secy., E. N. Clark, Pittsburg, Pa.

CENTRAL RAILWAY CLUB OF BUFFALO.
June 23. Secy., Jas. Macbeth.

AMERICAN INSTITUTE OF MINING ENGINEERS.
June 28. Bluff Point, N. Y. Secy., R. W. Raymond, New York.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
July 1. Secy., E. K. Smoot, 808 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
July 1. Secy., O. von Geldern, 819 Market St., San Francisco.

SWEDISH ENGINEERS' CLUB.
July 2. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.

NORTHWEST RAILROAD CLUB.
July 2. Union Station, St. Paul.

ASSOCIATION OF ENGINEERS OF VIRGINIA.
July 4, 5. At Richmond. Secy., J. R. Schick, Roanoke, Va.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
July 7. Secy., T. G. Pihlfeldt, 113 Adams St.

WISCONSIN POLYTECHNIC SOCIETY.
July 11. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
July 11. Secy., C. L. Annan.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
July 14. Secy., Edward Mead, Norton Building.

ENGINEERING ASSOCIATION OF THE SOUTHWEST.
July 14. Secy., O. H. Landreth, Nashville, Tenn.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Aug. 18. At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 7. Secy., F. Collingwood, 127 East 23d St., New York.

ENGINEERS' CLUB OF ST. LOUIS.
Sept. 21. Secy., Arthur Thacher, Odd Fellows' Building.

ENGINEERS' CLUB OF CINCINNATI.
Sept. 21. Secy., J. F. Wilson.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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VOL. XXVII. THURSDAY, JUNE 16, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST..... .....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon: new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The continued silence of the writer of the communication signed "Civil Engineer" and published in our issue of Oct. 24, 1891, in spite of our repeated requests that he will either support his statements or withdraw them, warrants us in concluding that that letter was an imposition on the confidence of this journal in the writer's apparent good faith. As we have stated, the letter must have been duly signed with some name or accompanied by an inclosed card, or it would never have been published at all, but it is impossible for us to remember at this distance of time what name was signed to it. The letter purported to describe the Indianapolis cattle guard tests, as stated in our issue of May 26. It gave an entirely different account of them from what we subsequently obtained from official sources, and we learn with deep regret that it is being circulated in aid of trade rivalries, reprinted as from this journal in order to establish its genuineness. We are now thoroughly convinced that the letter was not sent us in good faith, and under the circumstances we deem it our duty to warn all our readers that no attention and no weight should be given to it in whatever form presented.

The breakage of the Spartansburg dam, which caused the recent flood along the valley of Oil Creek, with its fatal results, seems to have been of more importance, from an engineering point of view, than was at first supposed. It is true the dam was only 10 ft. in height, but it impounded a body of water whose extreme dimensions were 1½ miles in length and a mile in width. According to press reports, the dam was built by driving piles for 150 ft. of its length, and earth, rocks and boards were heaped against them. The remaining 30 ft. was an earth and rock fill without piling, and it was this part of the dam which was washed out, according to reports. It is pretty fair proof of the rough and ready construction of the dam that no waste weir other than the flume for the sawmill seems to have been provided. When the pond overflowed it simply ran over the face of the dam, and when the flow was greatly increased by unusual rains, the washing away of the earth and rock wall was what might have been expected. It is stated, indeed, that the dam broke away seven years ago, causing a serious flood, but was rebuilt in the former haphazard manner. Some of the Pennsylvania papers are beginning to discuss the establishment of a system of State inspection for dams and reservoirs; and with the record of Spartansburg added to that of South Fork, an unprejudiced observer would judge it to be quite time.

There are at least five planks out of the 20 in the new Republican platform on which good citizens of all parties ought to be able to unite, and which all relate more or less directly to engineering issues, as follows:

V. We favor the extension of our foreign commerce, the restoration of our mercantile marine by home-built ships, and the creation of a navy for the protection of our national interests and the honor of our flag.

VIII. We favor efficient legislation by Congress to protect the life and limbs of employees of transportation companies engaged in carrying on interstate commerce, and recommend legislation by respective states that will protect employees engaged in state commerce, in mining, and manufacturing.

XIV. The construction of the Nicaragua Canal is of the highest importance to the American people; but as a measure of national defense and to build up and maintain American commerce it should be controlled by the United States government.

XVI. We favor cession, subject to the homestead laws, of the arid public lands to the states and territories in which they lie, under such congressional restrictions as to disposition, reclamation, and occupancy by settlers as will secure the maximum benefits to the people.

XVII. The World's Columbian Exposition is a great national undertaking, and Congress should promptly enact such reasonable legislation in aid thereof as will insure a discharging of the expense and obligations incident thereto and the attainment of results commensurate with the dignity and progress of the Nation.

We shall be surprised and disappointed if the substance of these planks does not appear also in the coming Democratic platform; and still other planks on which there is little likelihood of dispute are those approving the Monroe doctrine, closer restriction of immigration (which last, however, is narrowed down to restriction of "criminal, pauper and contract immigration" only), and free delivery of country and village mail matter. It is a decided evidence of the increase in relative importance of engineering questions that not less than 5 out of 20 planks in a party platform should relate directly to them.

As our readers will remember, this journal has offered three prizes of $75, $50 and $25 for the best three graduating theses of 1892 graduates in engineering which may be entered for the competition on or before July 20, 1892, with honorable mention to such others as might seem to demand it. The conditions for the competition were published in full in our issue of Jan. 30, 1892, and two of these conditions were that the theses were to be sent in through the college authorities and not by the authors, and were to be sent in anonymously both as to author and college. A very pertinent inquiry reaches us from one engineering school as to how this required anonymity is to be secured, since if sent either by mail or by express the post mark or express mark would reveal the place from which they were sent, whence an inference as to the college from which they came would be easy.

In response we may say (1) that many packages of the same general nature are received by this journal daily, and when not addressed to the editors by name are habitually opened by the mailing clerk in another room. We have given strict injunctions that this practice shall be rigidly adhered to from now until July 20, when the time for receiving theses closes, since we naturally feel a very earnest desire to know nothing about the origin of theses until the awards have been made. But (2) we should prefer in all cases to have them sent to some person in New York to be opened by him and delivered to us unwrapped; or (3) parcels may be addressed to Mr. Francis Collingwood, Secretary Am. Soc. C. E., 127 East 23d St., New York, who has kindly consented to forward the contents of such packages to us from time to time if he finds them to be addressed to us inside.

We may add further that, in order that it may not even be apparent whether the theses come from a large or small college, or whether any two of them are from the same college, we should prefer to have each thesis sent by itself in separate inclosures and on different dates.

As each thesis will probably pass through six to eight different hands, furthermore, not more than one of whom could possibly have means of guessing the origin, if even he should chance to, we think all intending competitors may count with confidence on the very desirable feature of anonymity being fully preserved. That each competitor may have justice done him and no more than justice is our earnest hope.

This year's convention of the Master Car Builders' Association will hardly be as important as the recent average in most respects, as there is no very important or decisive action to be taken at it; but in one respect at least it will be notable. For the first time the association will have some definite information before it as to how much acceptance the various standards have met with which it has been putting forth yearly for nearly 20 years past. We have often suggested that this should be done, and this year a committee headed by Mr. R. H. Soule has done it very thoroughly.

The result is not altogether encouraging. In the first place only 111 out of 540 members responded at all, even to so important an inquiry as this. The principal delinquents were those who represent no cars, but even of the representative members only 42 out of 114 sent in any replies (37%) even after two requests. The remaining 63% refused to give any sign as to their practice, and it is only a reasonable and natural inference that the 63% who would say nothing were paying less attention to the association's standards than the 37% who responded. On the other hand, it would be highly unreasonable to assume that those who did not respond were not using the standards at all, and there being no other possible basis of a definite nature, the committee seem to have agreed to take the respondents as fair representatives of the whole, though they do not distinctly say so.

It is quite possible that this assumption nearly doubles the actual percentage of those using the standards, but a large proportion of them are more honored in the breach than the observance, even on the face of the returns.

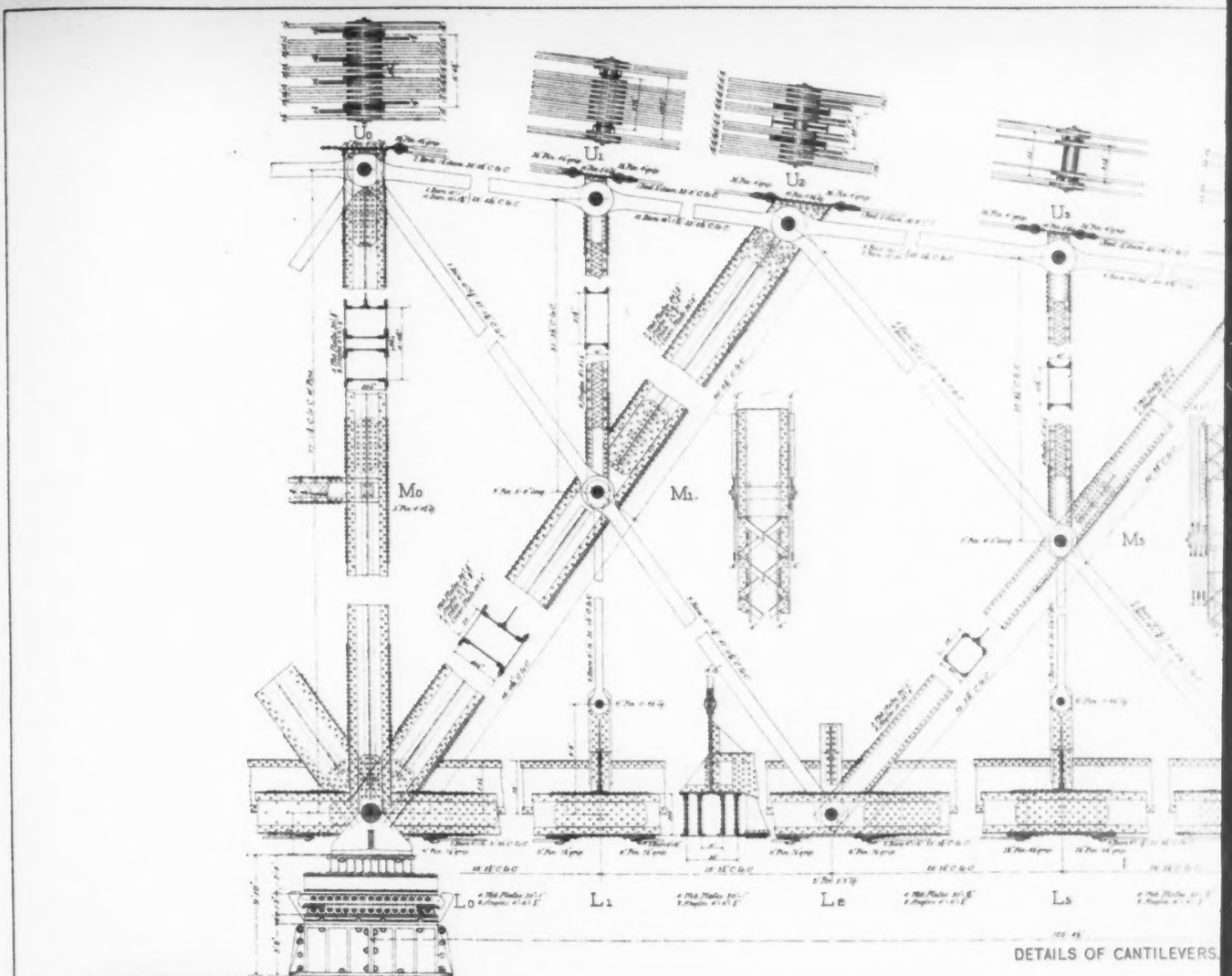
We have tabulated the facts discovered by the committee, and reported by them, in a form a little more convenient for ready reference and comparison as follows. It must be remembered always that the returns represent a minority only of all the roads in the country:

Percentage of the Roads and Cars Reporting (63% of the Roads not reporting at all) which have adopted and use the several M. C. B. Standards:

	Roads. P. c.	Cars. P. c.
Wheel tread section, cast wheels....	84	70
" " " steel tired.....	67	62
Axle, 4¼ × 8 in. journal	60	50
" " "	72	62
Wheel circumference, measure.....	100	100
Journal box for small axle.....	73	50
" " " large axle.....	60	50
" " lid	Rarely used.	
" bearing and wedge.....	73	50
Vertical plane coupler	Generally used.	
(Attachment of drawbars).....	Disregarded.	
Height of drawbar, 33 in. (ft.).....	54	
" " " 35 in. (pass.).....	Generally used.	
Brake shoe and head, Christie.....	61	76
" " " Collin.....	26	11
Iron Brakebeam (Westinghouse)....	Seldom used.	
" " (National Hollow).	83	80
Angle of brake lever.....	Generally used	
Train pipe pressure (70 lbs.).....	"	"
Per cent. of weight braked (70%).....	"	"
Air brake lever arrangement.....	Almost universal.	
Rod and lever details, air brake	"	"
Location of dummy couplings.....	"	"
Passenger truck pedestal.....	Generally used.	
Screw threads.....	Almost universal.	
Cast iron wheel specifications...	54	41
" " guarantee.....	40	32
Protection of trainmen.....	Generally neglected.	
Dead blocks.....	Wholly neglected.	
Platform safety chains.....	50 (but not std).	
Truck " "	...Generally used.	
Capacity of draw springs.....	"	"
Limit gages, round iron.....	Little used.	
Loading logs, poles and bark.....	Generally used.	
Marking cars.....	Generally used.	
Lettering and numbering line cars...	Little used.	
(Boring wheels; 6 dogs).....	Not used.	
(Train pipe fitting for steam heat)....	"	"

The three standards in (parentheses) above, as also seven different kinds of gages for use about wheels and axles, are recommended for abolishment, on the double ground that they are not used, and that it does not concern the association how various standard dimensions may be secured. No doubt some further interesting facts will develop in discussion, which, with some further incidental discoveries embodied in this valuable report, we shall give in our next issue.

Of the numerous cases which come before the Arbitration Committee of the Master Car Builders' Association for investigation and decision, there are few which involve any principle of importance and



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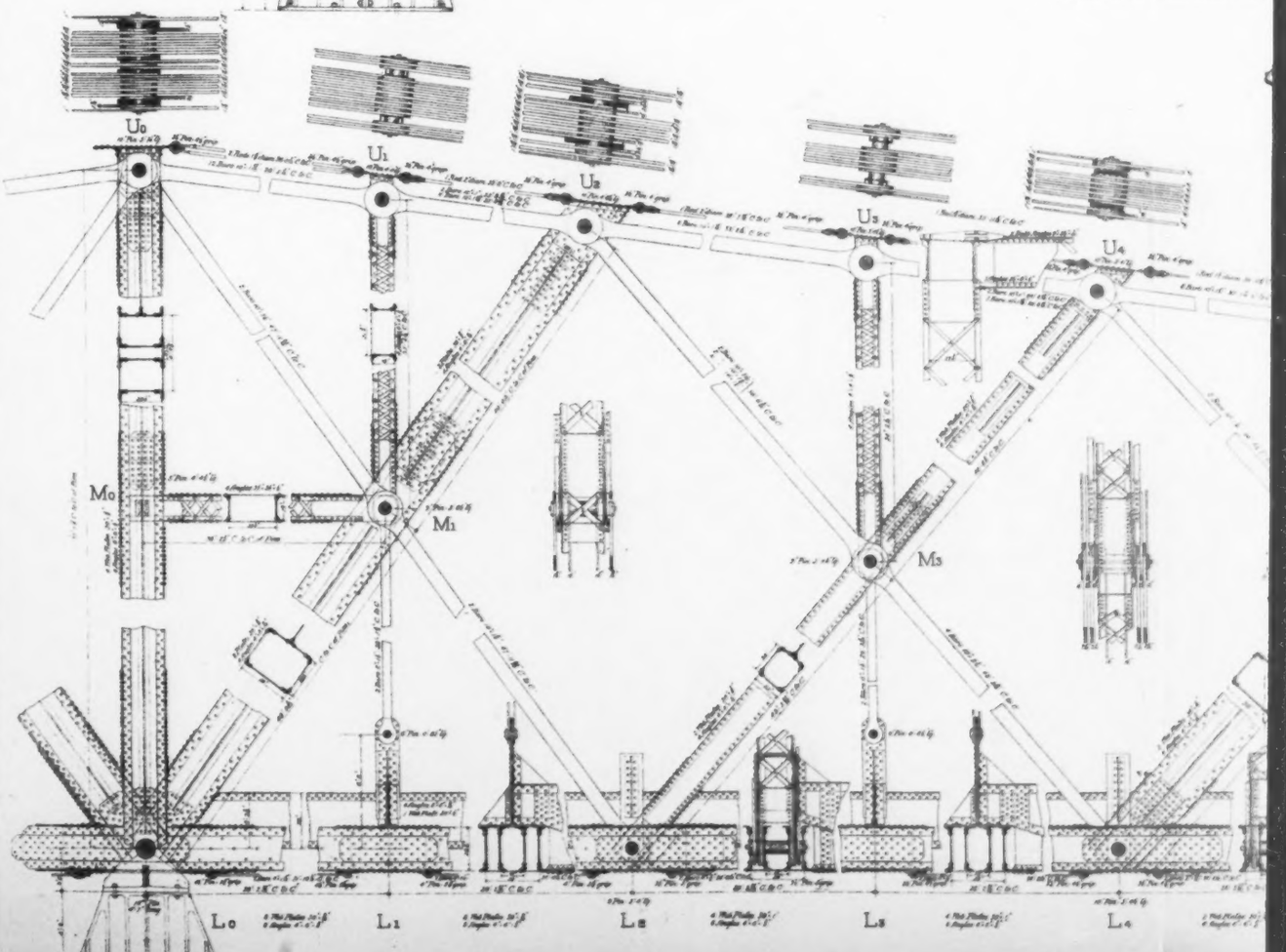
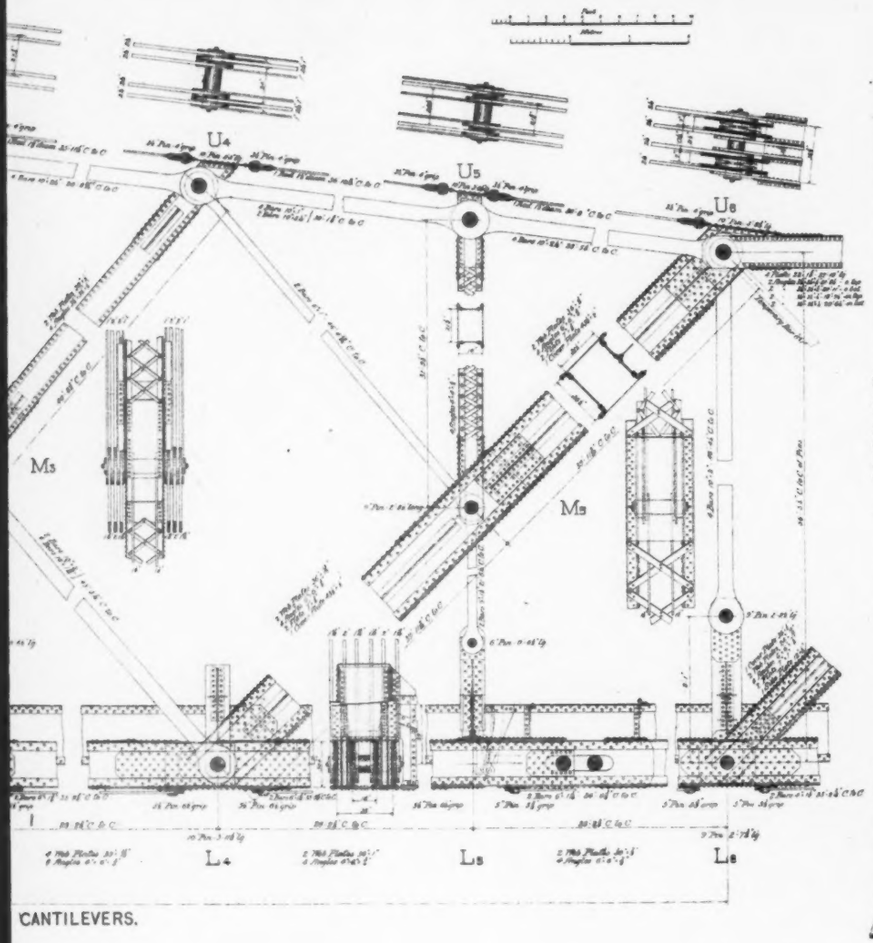
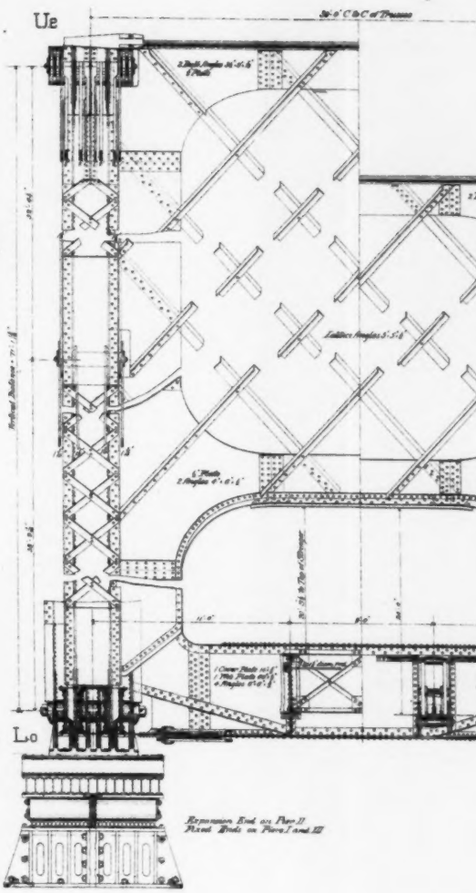
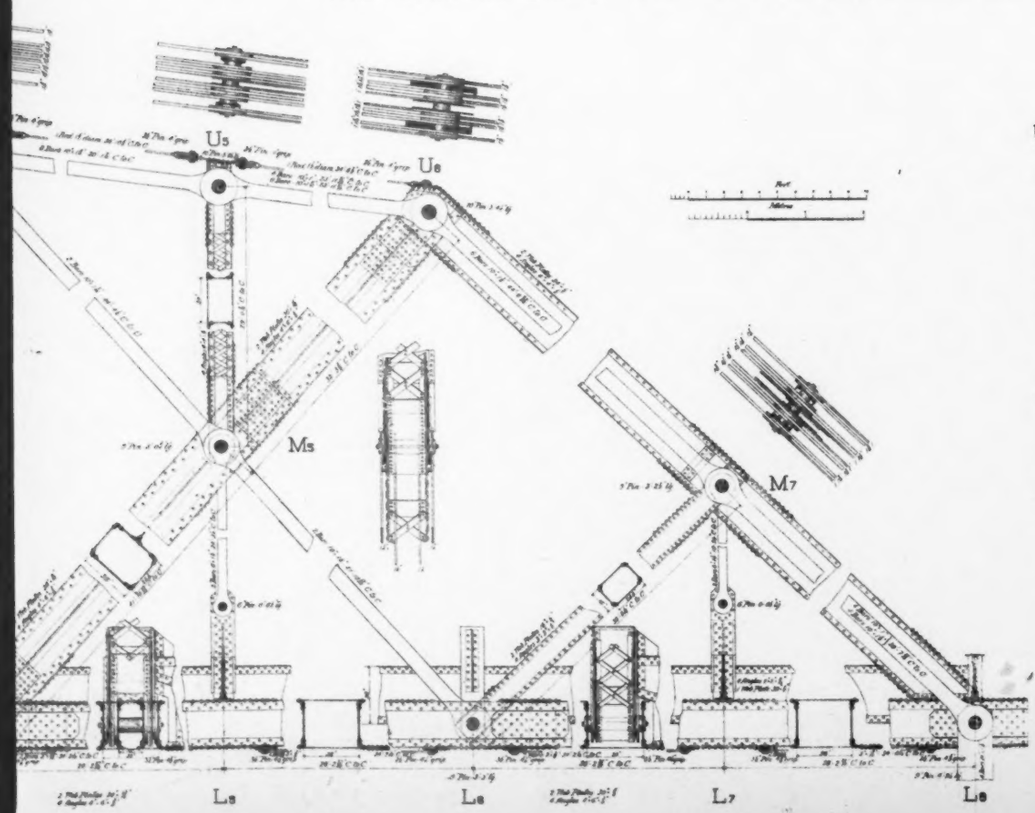


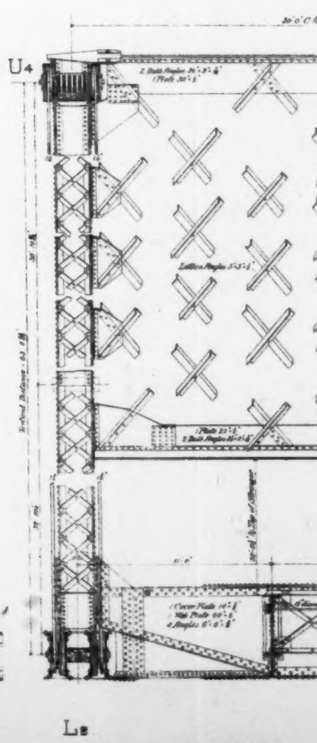


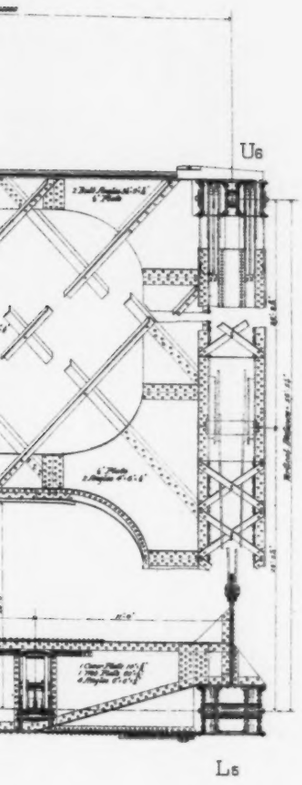


CANTILEVERS.

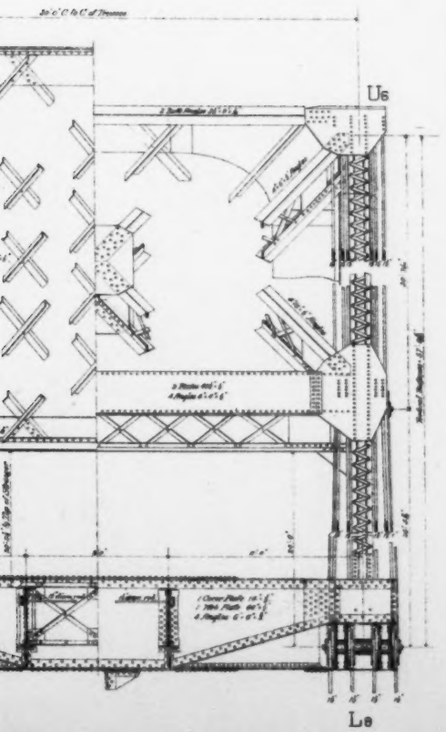
THE MEMPHIS BRIDGE OVER THE MISSISSIPPI RIVER AT MEMPHIS, TENN.; G







N.; Geo. S. Morison, Engineer.



which might not as well be settled by the parties at interest if they would but make a fair and impartial application of the interchange rules and exercise a little mutual forbearance. In a case recently decided, however, a principle of very considerable importance was at stake, and it deserves a word of comment. It seems that some cars belonging to the Chicago, Rock Island & Pacific Ry. had their wheels cracked through the tread while on the Colorado Midland R. R.; the cause of failure was evidently heating, as the brake shoes were burned red. Bills for the wheels were, therefore, rendered against the Colorado Midland Ry., it being claimed that this was unfair usage, for which the owner was not responsible and for which the company causing the damage should pay. On the other hand, the Colorado Midland Ry. refused payment of the bills, claiming that the cars received the best usage it could give to cars passing over its line; the wheels broke on account of the iron getting hot while coming down a 4% grade, and it was impossible to bring cars down that grade without the wheels heating. In effect, therefore, the claim was that while the service was severe, it was no more severe than the wheel ought to endure without injury, and its failure was merely evidence that the wheel was not of as good quality as it should be. Therefore, the owners of the car had no right to claim payment.

The Arbitration Committee considered that the principle involved was whether a road operated under extraordinary conditions and on account of these conditions damaging a car of another company should pay for that damage. Manifestly on this basis they were obliged to decide against the Colorado Midland Co. The owner of a car who virtually leases it for use on another road, is, of course, entitled to payment for its damage through unfair or extraordinary usage.

We wonder whether the importance of this decision and its bearing on a question now before the M. C. B. Association, which is of great importance to a large number of manufacturers, will be perceived. The railways of the country three years ago proposed to the cast iron wheel makers that wheels should be paid for according to the mileage made, and those which failed in service on account of defects which were specified should not be charged to the railways. The wheel makers said: "Very well, but a number of these defects which you claim to be due to poor manufacture we believe to be due to the long continued application of brakes, and therefore we cannot consent to give up claim to payment for wheels failing from these defects." The Arbitration Committee by this decision have expressed the opinion that the cracking of wheels from the application of brakes is improper usage, for which the owner of the car can recover. But if this is so, it is difficult to see why the maker of the wheel should be held responsible for the failure. It is true that few wheels will crack even when subjected to this severe service, and the car-builders hold, we believe, that all wheels ought to be made strong enough to endure it. If they adhere to this view, however, they ought in consistency to reverse the decision of the Arbitration Committee in the case above cited. If good wheels ought not to fail under severe application of brakes, then the car owner should put such wheels under his cars, and stand the loss if the wheels crack.

It is interesting in this connection to see how much heat will be generated in car wheels in coming down grades, as we believe the heating is generally overestimated. Let us assume a loaded car weighing 80,000 lbs. In coming down a grade, for every 100 ft. of vertical fall $100 \times 80{,}000 = 8{,}000{,}000$ ft. lbs. of energy will be generated. If a hill or level stretch occurs at the end of the 100 ft. fall, part of this energy will be used in giving the train higher speed. In any case part will be used to overcome the air resistance, axle friction, etc., in running down the hill; but on the steepest grades this would amount to little; so we will assume that the brake shoes have to absorb all this energy, converting it into heat by their friction. Since the mechanical equivalent of one heat unit is 772 ft. lbs., the amount of heat generated at the brake shoes will be $8{,}000{,}000 \div 772 = 10{,}363$ h. u. This heat is divided between eight wheels and brake shoes, hence the heat units per wheel will be $10{,}363 \div 8 = 1{,}295$. The specific heat of iron is 0.1138, and the weight of a car wheel is about 550 lbs., therefore if we suppose this amount of heat to be equally distributed through the wheel, its temperature will be raised only $(1{,}295 \div .1138) \div 550 = 20.7°$. In fact, however, in running down a steep grade the heat does not have time to distribute itself through the wheel. Suppose it is confined to an outer ring having one-fourth the weight, then the increase in temperature will be about 82° per 100 ft. fall in grade, which on a 4% grade means a run of about half a mile, made in perhaps three minutes. It is evident from this that, even neglecting the continuous cooling by radiation, serious heating of wheels is not likely to occur until a car has run at least 300 vertical feet down a grade; and a due allowance for the loss of heat by radiation and by conduction to the interior parts of the wheel would perhaps double this distance. Nor is it likely to occur except on very steep grades, since on moderate grades the time taken to run down is sufficient to give the wheels opportunity to cool. Certainly, in the interest of safety, to say nothing of saving the wheels from injury, the regulations on roads having steep grades should oblige the speed in running down them to be kept low enough to prevent overheating the wheels.

It will be noted that the above calculation is based on the whole weight of the car being braked, as is the case when air brakes are used, although we understand some economical (?) roads have lately been putting on air brakes to one truck only of eight-wheel cars. With hand brakes, however, heating of wheels is liable to occur on moderate grades, if very long, the brakes being set on only a few cars, and being set there as hard as the brakeman's muscle will permit. So long as hand brakes are in general use the wheel makers are not likely to consent to pay for cracked wheels.

THE CAST IRON LINING OF THE HUDSON RIVER TUNNEL.

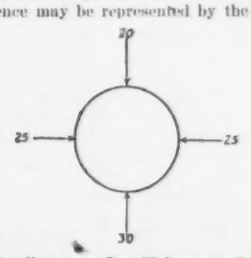
Few more difficult tasks in tunneling have ever been attempted than the one which has been partially completed between New York and Jersey City under the North River. It is 19 years since the Hudson Tunnel R. R. Co. was chartered, on May 26, 1873. Ground was broken in November, 1874, but for five years work was kept at a standstill by litigation. In September, 1879, the company having won the suits brought against it, work was actively pushed and continued until the fall of 1882, when work stopped for lack of money. During this time about $1,050,000 was expended. On the New Jersey end the north tunnel was advanced 1,839 ft., and the south tunnel 550 ft. At the New York end the south tunnel was barely started, while the north tunnel had advanced 145 ft. The plan of the work contemplated two tunnels side by side, of circular cross-section, 12,000 ft. long, with approaches.

From 1882 to 1889 the work was untouched; during the latter year about $1,500,000 was raised in England and work was resumed, the Greathead system of tunneling being substituted for the systems which had been previously in use, by advice of Messrs. Fowler and Baker, the well known engineers. By July, 1891, the funds which had been raised were spent, with the result of completing 2,076 ft. more on the north tunnel. A very considerable amount was spent in repairing the old work and in the accumulation of the plant necessary to carry on work by the Greathead system. It is evident, however, that the cost of excavating the tunnel must have been pretty large to absorb funds so rapidly. The St. Clair tunnel cost about $333 per lin. ft.; and since work was considerably more difficult in the Hudson River tunnel, it seems not improbable that it may have cost $500 or more per foot. There still remains to be completed 1,600 ft. on the north tunnel, nearly the whole of the south tunnel, or about 5,000 ft., and the approaches for both tunnels, some 4,000 ft. on the New Jersey end and 4,500 ft. on the New York end, in all about 23,600 ft. If the north tunnel and approaches be completed alone, only about 10,000 lin. ft. will have to be excavated; but it is evident that a single-track tunnel could handle only a small part of the traffic. What portion of the approaches would be in rock, if any, we do not know, but we suppose that a considerable portion at least would be in soft material, necessitating the use of the shield and iron lining. Any estimate of the cost of completing the tunnel without knowledge of the material which the approaches will penetrate might be far out of the way. Knowing the distance to be tunneled through soft material, however, a very close estimate of the cost of completing the tunnel ought to be possible, with the cost of the St. Clair tunnel ($333 per lineal foot) and the cost of the work already done in the Hudson River tunnel as a basis.

It is, however, in the tunnel as an engineering work that our readers are chiefly interested, especially as it is the first instance in which the shield or Greathead system of tunneling has been used in other material than clay. We call the method used the "Greathead" system for convenience, but as a matter of fact the shield was designed by Sir Benjamin Baker, and was similar to one designed by him (but not built) for the Humber tunnel in 1873.

The most interesting fact concerning the work which has come to our knowledge is that the cast iron lining has cracked badly in several places. No such thing has occurred in any other tunnel built on this system, so far as we are aware, and the reason is evident. The other tunnels have been built, for the most part, through a rather stiff clay. The Hudson River tunnel is built through a remarkably soft silt, so soft that it will flow like a viscous liquid, even through so small an aperture as a rivet hole. It is doubtless the fluidity of the material that has caused the distortion of the tunnel. Suppose the circle below to represent the cross-section of the tunnel, and suppose the external pressures upon it to be approximately proportional to the depth of the material above, and the depth to be twice the diameter of the tunnel. It is really considerably more, but the principle is not affected by this slight exaggeration, especially as the distorting force depends only on the difference between the top and bottom pressures, which is independent of depth.

Then the relative pressures at four points of the circumference may be represented by the quantities



given in the diagram. It will be seen that the side pressures balance each other while the upward pressure exceeds the downward—that is, the tunnel is buoyant. This buoyancy is reduced by the weight of the tunnel lining, permanent way, etc., but this weight is far less than the buoyancy, and if the material penetrated were a fluid, the tunnel would rise through it. The material is solid enough, however, to prevent the tunnel from rising; that is to say, since the tunnel does not, in fact, rise, the pressure (30) on the bottom (see diagram) must be balanced by an equal and opposite pressure on the top, which is obtained from the coherence of the material. It is thus seen that the vertical pressures on the tube are in excess of the horizontal pressures, and as a result the tunnel has shown a tendency to change from a circular to an elliptical form, the longer axis being horizontal. This distorting force has proved strong enough to break plates in the sides of the tunnel just above the middle. The plates failed, we understand, by breaking through the body, not by breaking of flanges or bolt holes.

So serious was this movement that it was deemed necessary to check it by tying the opposite sides of the tunnel together with horizontal rods tightened by turnbuckles, an expedient which, of course, can only serve temporarily, during construction.

A great deal has been written about the enormous strength of a cast iron lining for tunnels, and perhaps engineers have been more or less influenced by it. As a matter of fact, a cast iron lining is exceedingly weak to resist forces tending to distortion of shape. To make this fact clear, consider a section of the tunnel lining as a ring without joints, of uniform thickness. In the Hudson River tunnel the lining is 1¼ ins. thick and the diameter of the tunnel cross-section is 19 ft. 6 ins. The strength of the tunnel to resist distortion is, of course, greatly in-

creased by the flanges for the circumferential joints; these form, in fact, a series of stiffening ribs. The tunnel lining may be considered, then, as made up of rings 19 ff. 6 ins. in diameter and 1¼ ins. thick, with stiffening ribs 8 ins. thick and 2¾ ins. wide at intervals of 20 ins. It can be easily seen that the strength to resist distortion of cast iron rings of such large diameter and small thickness is very small. We have, in fact, a case of transverse stress, the strength of the ring to resist distortion increasing directly as the cube of its depth and decreasing as the diameter increases.

As proof of this general fact (if proof were needed) the fact might be cited that the portion of the Hudson River tunnel which is lined with a 2-ft. ring of brick masonry is standing intact without cracks, and has thus proved its superiority to the cast iron lining, so far as this especial feature is concerned.

It may be asked, why not increase the depth of the cast iron lining, or rather of its stiffening rings? The main reason is that a limit is soon reached on account of the expense. At best cast iron is a very costly material for tunnel lining. The St. Clair tunnel lining cost about $135 per lineal foot, more than the entire cost of any save the most expensive rock tunnels. Evidently the use of cast iron should be attended with many benefits to compensate for its cost. This is, indeed, the case. The cast iron lining is water-tight; it has great strength to resist pressures equally balanced on all sides, and to resist longitudinal strains. Most important of all, in connection with the use of a hydraulic tunneling shield, it affords a solid abutment for the jacks to push against, and it can be placed in position at the tail of the shield so rapidly as to leave no unlined space behind.

All these advantages, however, count for little unless the lining has sufficient strength to resist distortion; and it must be remembered that the greatest trial of the strength of a tunnel lining in such material as the Hudson River silt will come when heavy trains are run through it. How will the vibration which will be set up affect this soft pulpy silt? Certainly if it affects it at all, it will increase rather than decrease the difference between the vertical and horizontal pressures and thus the distorting force. The lining to be used ought certainly to have a large margin of safety against such a chance as this. So far this has not been provided for on the work recently done.

On the other hand, it seems clear to us that mere brick masonry is not a proper material with which to build a tube for a railway line beneath a great river, through a material so soft that paving stones and bricks dropped from schooners above have worked their way down through 20 to 30 ft. of mud and are found by the tunnelers in their work. One feels an instinctive preference for something that will hang together better under tensile strains. It is true, too, that except a little work at the York Road tunnel of the Baltimore Belt R. R. (see Eng. News, Jan. 9, 1892) nothing has been done with hydraulic shields in tunnel work in connection with brick lining, whereas the cast iron lining is a great aid to the use of such shields. The only difficulty with brick masonry for such use is that some time must be given for the mortar to set, but this is a very serious difficulty, involving much delay and a pretty heavy lining.

The logical conclusion would seem to be the use of cast iron and brick in combination for tunnels built through very soft and uncertain material. It is the weight of the cast iron lining which makes it expensive. The St. Clair lining weighs 9,333 lbs. per lin. ft. This weight is necessary in order to secure sufficient thickness to resist distortion; but with an inner lining of brick acting as a brace to stiffen the iron lining and assist it to resist distorting strains, much thinner plates could be used, and the longitudinal strength and the strength to resist the thrust of the jack would still be ample. A reduction of one-half in the weight of the St. Clair lining, for instance, would mean a saving of about $67 per lin. ft., which would be ample to cover the cost of a 2-ft. ring of brick masonry inside the iron lining, and also, in most cases, of the larger excavation necessary.

An added virtue of this lining which should not be overlooked is that the buoyancy of the tunnel is considerably reduced compared with that of one lined with cast iron alone.

It is of interest to note that the new Blackwall tunnel under the Thames, for which the contract has just been let, and which is elsewhere described in this issue, will have a combination iron and brick lining, although the brick ring will be only 14½ ins. thick, and the weight of the cast iron plates has not been reduced. The very large diameter of the tunnel, 27 ft. outside, by far the largest of any tunnel thus far driven on this system, makes the added stiffness secured by the ring of brick of much importance.

We are here discussing the general problem only, of course, not the particular steps which should be next taken with the Hudson River tunnel. So far, the company does not appear to have gained much over Mr. Haskin by going across the water for its engineers; but it must not be understood that we propose to remedy the oversights of either the old or the new engineering staff by prescribing a brick and iron lining as a remedy for the troubles which have been encountered.

It will not be possible to line with brick the cast iron shell of that portion of the tunnel at present completed, for the extreme height of the cross-section is even now none too large. Perhaps the sides of the tunnel may be stiffened by bracing sufficiently to prevent further distortion and without reducing too much the side clearance. As for the remainder of the north tunnel still to be driven, with the shield system of tunneling it is a very difficult matter "to swap horses while crossing a stream." It would certainly tax the resources of engineering to replace the present shield with a larger one in its present position. If work is resumed on the tunnel, this shield will doubtless be pushed through to the New York side, and the iron lining will be made safe in the best way available.

It is a fact of some interest in connection with the Hudson River tunnel, and of very much interest in connection with the general problem of tunnel construction of the Greathead system, that the same contractor who has driven the last 2,000 ft. on the Hudson River tunnel and spent the million and a half contributed by Englishmen has just taken the contract for the Blackwall tunnel under the Thames elsewhere described. The engineer's estimate for the Blackwall tunnel was $400 per lin. ft. The price at which the contract was let is $4,355,000, or $702 per lin. ft., for the whole tunnel, including the open cut approaches. The portion of the tunnel under the river which is lined with cast-iron forms but one-fifth of the total length on which this price of $702 per ft. is based. Evidently the work done by Messrs. Pearson & Son underneath the North River has not tended to diminish their appreciation of the risk and expense of submarine tunneling on the Greathead system.

A small ocean steamer has recently made a trip direct from Bergen, in Norway, to Chicago. The steamer is the "Wergeland," a steel freight boat of 400 tons, built at Bergen in 1881, and employed generally in the trade between Norway and the West Indies. She has a draft of 13 ft. 6 ins., and as there was only 7 to 9 ft. of water in the Murraysburg and Lachine canals, nearly the whole of the cargo (3,000 barrels of herrings and cod liver oil) had to be taken out at Montreal and reloaded at Kingston, adding about $1,000 to the expense, which would have been avoided by deep water communication between the St. Lawrence and Lake Erie. The "Wergeland" left Bergen April 14, and Montreal May 12, and arrived at Chicago May 26, having made a voyage of 5,100 miles, 2,000 miles of which were in fresh water, in 42 days, including detention for unloading, transferring the cargo by lighters, and reloading. The vessel will take an outward cargo of flour and provisions, and Mr. Thorp, the merchant who chartered her for the trip, is said to intend repeating the experiment if the financial result is satisfactory.

London electric railway schemes have been reported upon by a joint committee of Parliament, who state that, in their opinion, electricity is a most valuable motive power, and that cables are very useful on steep gradients. They, therefore, recommend that the different electric and cable bills should be allowed to go forward. They suggest that, as the companies acquire the sub-soil without consideration, they should be required to provide an adequate service of cheap and convenient trains for the working classes. More lines of communication are required from the city to suburbs. They report in favor of a minimum diameter for the tunnels of 11 ft. 6 ins.

LETTERS TO THE EDITOR.

ALUMINUM CANTEENS AND EQUIPMENTS.

Sir: In your issue of June 2, a correspondent inquires where he can purchase canteens made of aluminum. I am glad to inform you that the Cincinnati Pure Aluminum Co., 7 Emery Arcade, Cincinnati, O., can furnish these articles, and that they are just now erecting a special set of machinery for the purpose of manufacturing these on a large scale, having a large number of orders for them, with the expectation of catering to the U. S. Army demand for these articles. Your correspondent can get canteens and many other articles of aluminum fabricated by the Scovill Mfg. Co., of Waterbury, Conn., as well. Very respectfully,

The Pittsburg Reduction Co.,
Pittsburg, June 7, 1892. Alfred E. Hunt, Pres.

EFFICIENCY OF PELTON WATER WHEELS UNDER HIGH HEAD.

Sir: In your issue of May 26 you gave a description of a water power installation recently made by us in one of the Comstock mines under very extraordinary conditions as to head. Your deductions as to efficiency are correctly based upon 2,100 ft. effective head. No account, however, was taken of the loss of head by friction in the supply pipe, which is 175 ft., reducing the effective head to 1,925 ft. The power developed per miner's inch used (equal to 1.6 cu. ft. per min.) on the wheel is 5 HP. The theoretical HP. of each 1.6 cu. ft. (100 lbs.) is 5.83 (the effective head being 1.925 ft.). Therefore the wheel gives an efficiency of $5 \div 5.83 = 85.7\%$.

The Pelton Water Wheel Co.

THE "NATIONAL BRIDGE & IRON WORKS."

Sir: We have in this city a bridge built by the National Bridge & Iron Works, of Boston, Mass., in 1872, and marked "Parker's patent." I have had a thorough examination of the bridge made by Prof. Geo. F. Swain, of Boston, and his report shows the bridge to be in an unsatisfactory condition, and recommends that a new bridge be erected in place of the old one.

Exception has been taken to this report by certain parties, and the statements have been made that there are 400 bridges built by this same firm in this country; that at the time this bridge was built, 1872, it was the longest span highway bridge in New England (span 195 ft.); that all the highway bridges of longer span in New England have been built within the last ten years. Have you any information at hand which will contradict any of these statements, which seem to me to be very questionable, or can you inform me what it was that compelled this firm to go out of existence?

I have been informed that the company was ruined by the failure of a railroad bridge built by them while it was being tested. Have also understood that bridges built by this firm have been taken out in other places. Any information that you may have in relation to the above will be very gladly received.

Yours respectfully,
Geo. A. Carpenter,
City Engineer.

Pawtucket, R. I., May 31, 1892.

(We recall little about the private history of this company or firm, but quite apart from the revelations in Prof. Swain's report, it would be a safe surmise that any bridge of long span, built in Boston in 1872, under somebody's patent, and for highway use, was a poor bridge even for its day, and to-day has long outlived its usefulness. There may possibly have been 400 bridges built by this firm, but we doubt it.—Ed.)

DISCONTINUOUS SWING BRIDGES.

Sir: In regard to priority of idea of discontinuous swing bridges, raised by a letter in your issue of May 19, and earlier issues, I beg to submit the following extracts from a pamphlet issued by the Keystone Bridge Co., in connection with their exhibit at the Centennial Exposition, Philadelphia, 1876. The description relates to the Raritan Bay swing bridge, 472 ft., total length, which at that time was the longest swing span ever constructed in the United States:

"The lower chords are parted at the center, so that the ends of the trusses may be adjusted by wedges to any desired elevation. . . . . Before the bridge is swung open the entire structure is lifted about 4 ins. by means of hydraulic rams, placed in the transverse girders of the drum, under the four central posts . . . . . When the bridge is rotated into the line of track, it is locked by automatic locks at both ends, and then by turning a valve, lowered on solid bearings on the drum and at the extremities, the projecting rails bearing in the same shoes that receive the rails of the permanent spans. About one-half of the dead weight of the structure is made to bear firmly on the solid adjustable supports on the rest piers. By this disposition of the load, the bridge is rendered firm and solid under

the weight of passing trains, and the trusses act as two independent spans. The weight of the entire structure above the drum is 600 tons. This immense weight is operated with ease by the engine, turning gear and hydraulic machinery. When one arm is loaded, the other arm does not rise and vibrate on the remote bearing, as is the case with swing bridges designed as continuous girders over three supports. This objectionable feature in continuous girder swing bridges can be obviated only by lifting both ends by suitable apparatus, or by holding down one arm when the other is loaded. In either case strains are caused in the trusses, for which special provision must be made in the proportions.

To obviate these difficulties the bridge was designed both as cantilever and as two independent spans, with the arrangement described to place one-half of the weight of the bridge on end supports.

In this form of pivot bridge a slotted link connection can be used at center of upper chords to destroy the continuity of the chords when the bridge acts as two independent spans. The bridge was designed by J. H. Linville, C. E., and constructed by the Keystone Bridge Co. for the New York & Long Branch R. R. Co."

Yours truly,

Frank C. Osborn.

Cleveland, O., May 25, 1892.

(We referred the above criticism, together with those which have appeared in previous issues on the same subject, to Mr. Turner, and append his reply as follows.—Ed.):

Sir: In regard to the priority of the idea of discontinuous swing bridges, referred to by Mr. Schaub and Mr. Osborn, I think both are somewhat in error. One or two of the oldest swing bridges in the country are of that type, the arms being wooden Howe trusses and the ends raised one at a time by drawing up the rods by means of cam and levers. I believe there are one or two still in existence in the vicinity of Boston. The device described by Mr. Warner and myself in your issue of April 16, has some very marked advantages over the Raritan bridge, as the ends may be raised any given amount with less than one-half the amount of work, since the center is not raised at all, and the arms are rotated about their inner ends instead of raising the whole bridge bodily. Moreover the raising gear is far less expensive. The same result may be accomplished by raising the arms at the ends and using slotted eyes in the bars over the center; the mechanism would be rather more expensive and the truss not as neat in form.

The detail shown by Mr. Patterson in your issue of May 5, is a dangerous one indeed, as I think he will be convinced if he would figure the strain in his toggle due to dead weight and consider the effect of the vibratory strains that would be produced by this unsupported toggle center jogging up and down with each deflection of either arm truss under live load.

Very truly yours,

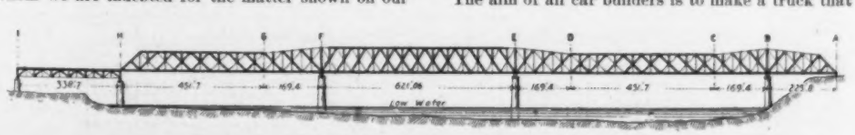
C. A. P. Turner.

Columbus, O., May 31, 1892.

DETAILS OF THE ANCHOR SPAN AND CANTILEVERS FOR THE MEMPHIS BRIDGE.

(With inset.)

We show on our inset sheet this week full detailed drawings of the anchor span and cantilevers for the Memphis Bridge, recently completed over the Mississippi River at Memphis, Tenn. The relative position and general arrangement of the anchor span and the cantilevers are shown in the diagram of the bridge given herewith; (A B) being the anchor span and (B C), (E D) and (F G) being the cantilevers, which are identical in size and construction. The diagram also shows the general dimensions of the bridge. The drawings on the inset sheet are shown in detail and largely explain themselves. A full description of the bridge was given in our issue of May 12, 1892, and engravings showing the progress of work were published in our issues of Feb. 27 and March 12, 1892. We expect to give further details of the structure in a future issue. Mr. Geo. S. Morison, M. Am. Soc. C. E., of Chicago, Ill., to whom we are indebted for the matter shown on our inset, was chief engineer. The iron work was done by the Union Bridge Co., of New York city, and A. P. Roberts & Co., of Philadelphia, Pa.

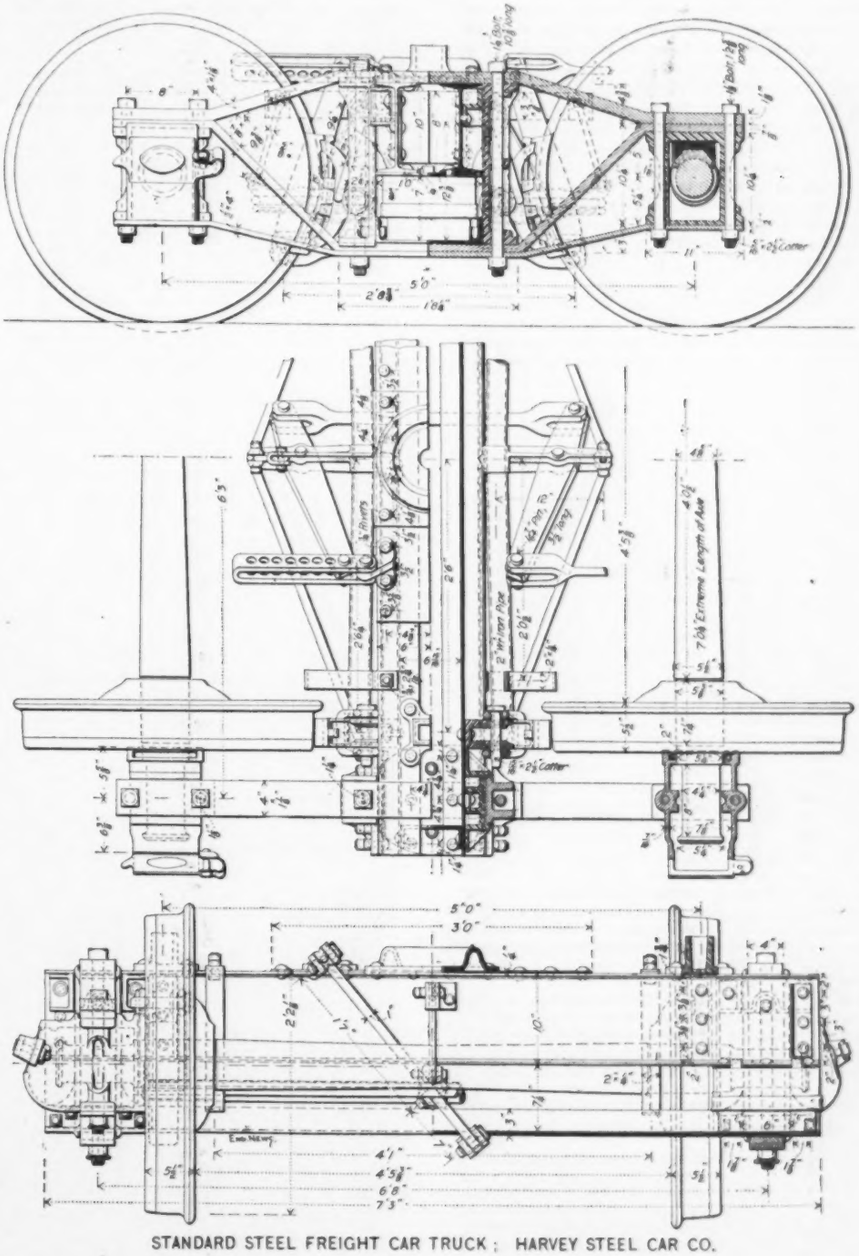


GENERAL ELEVATION OF THE MEMPHIS BRIDGE; Geo. S. Morison, Chief Engineer.

STEEL FREIGHT CAR TRUCK; HARVEY STEEL CAR CO.

In our issue of May 19 (pp. 499 and 508) we discussed the advantages of steel railway cars and the progress in steel car construction. We referred to the steel cars built by the Harvey Steel Car Co., of Chicago, one of which was described and illustrated in our issue of July 11, 1891, and this week we give the drawings of the standard type of truck used by this company under its cars. It is of the diamond pattern, with I-beam bolster.

The aim of all car builders is to make a truck that will meet the requirements of every class of service, and the evolution from the wooden truck of 35 years ago up to the steel truck of to-day has been one of marked progress. The former was composed of two axles, four wheels, four oil-boxes and brasses, two wooden wheel pieces bolted directly on top of the boxes, to the center of these the cross timber or bolster, on top of the bolster the center plate and side plates. The steel trucks of to-day are mainly of two types, the Fox pressed steel plate and the Harvey. The former will be the ideal of the followers of the pedestal frame principle, and the latter will conform to the views of those who think that the diamond or arch bar type is correct. The accompanying cuts show the Harvey truck in detail. The leading feature is the bolster, which is composed of two steel I-beams, 10 ins. high, weighing 24½ lbs. per ft. These are fastened together with steel plates across the top and bottom at ends and center. Malleable cast column guides are riveted at their proper places. The spring beam is a 12-in. channel, weighing 20 lbs. per ft., and the columns are riveted to the flanges of the spring beam. The wheels are 33 ins. diameter, and the wheel base is 5 ft. The arch bars are 4×1¼ ins., the inverted arch bars 4×⅞ in., and the pedestal tie bars 4×½ in. The width over frames is 7 ft. 3 ins. This truck has an advantage over others in the stiffness



STANDARD STEEL FREIGHT CAR TRUCK; HARVEY STEEL CAR CO.

of the top bolster, both vertically and laterally. There being no timber in it, there is no chance for shrinkage, which is one of the great troubles in car construction, and to overcome which much time and thought have been devoted. It is seldom that a perfectly sound seasoned timber can be obtained to use in truck construction, and therefore there is more or less shrinkage, which means loose bolts, resulting in the truck frames becoming out of square, which is a prolific cause of sharp flanges. It is said that if a rigidly square truck could be made, the number of wheels removed on account of sharp flanges would be reduced 50%, and the Harvey truck is claimed to come the nearest to being rigidly square of any in use, for the reasons above given, viz., no timber, no shrinkage, no loose bolts. Another point in favor of the Harvey truck is that it has a minimum deflection of the bolster, obviating one cause of hot boxes. To cure hot boxes has been the study of years, but the only perfect cure is to correct the cause, which is largely mechanical. A truck that has a rigidly square frame and a bolster that will not show any deflection under the maximum load, will not have many hot boxes. The Harvey truck is claimed to fill these requirements more nearly than any other type of truck yet designed.

THE IRREGULAR WEAR OF LOCOMOTIVE DRIVING-WHEEL TIRES.*

At the meeting of this club in February, 1891, Mr. J. N. Barr read a paper on this subject, giving data in regard to a particular case of irregular tire wear. Shortly after this time the writer arranged to systematically measure the irregularities of tire wear of all locomotive driving-wheels passing through the principal shop of the C., M. & St. P. Ry. at Milwaukee. In addition to making these measurements the weight of counterbalance in the wheels was taken and all rods and reciprocating parts were also weighed. The engines passing through this shop include eight-wheel freight and passenger engines, switch engines, and ten-wheel freight engines. The latter only will be considered in this paper. The following are the principal dimensions and weights necessary to determine the rotative force and pressure of each wheel on rail at various speeds and all positions of crank:

Cylinders, 19 × 26 ins.
Drivers, new tire, 62 ins.; taken here at 60½ ins.
Length of main rod, 10 ft.
Diameter of piston rod, 3¼ in.
Total weight on drivers, 84,000 lbs., distributed equally.
Weight of reciprocating parts, viz., piston, piston rod, cross-head and forward end of main rod, 729 lbs.
Steam pressure, 150 lbs.
Weight of back end of main rod taken as a revolving weight.

The tires of 53 engines of this class were measured Unfortunately they were not all counterbalanced alike, but all agreed in having the forward and back wheels overbalanced and the middle or main wheels underbalanced statically in 70% of the engines, and in all cases underbalanced according to the rule now followed on the C., M. & St. P. Ry. of adding to the weight necessary to balance the revolving weights two-thirds of the weight of the reciprocating parts, divided equally between the wheels. The weights of overbalance in forward and back wheels and underbalance in main wheel average as follows:

Front wheel, actual average overbalance, weighed at crank pin, 271 lbs.
Main wheel, actual average underbalance, weighed at crank-pin, 80 lbs.
Back wheel, actual average overbalance, weighed at crank-pin, 237 lbs.

The pressures upon the piston used in these calculations were obtained from actual indicator cards taken at these speeds, and with a point of cut-off found by the examination of a large number of cards to be the usual point at which engine is worked in freight service at the speed taken. The points of cut off used are as follows:

Speeds, miles per hour	10	20	30	40
Point of cut-off, inches	13	11	8	6

Formulas were developed (which we do not reprint), and by their aid the total pressure of each driving wheel on the rail and the total rotative force exerted on each wheel at the rail were calculated for every 10° of revolution, and at speeds of 10, 20, 30 and 40 miles per hour. By adding these figures the total pressure of all drivers on the rail and the total rotative force were obtained and are shown for each speed at each 10° of revolution of the drivers in the accompanying diagrams. The point 0° is taken in all the diagrams as the point of contact between tire and rail on right side of engine when the right crank is on the forward center. The movement of the engine is supposed to be forward. Dividing the total wheel pressure by the total rotative force we have the "coefficient of slip." When this quantity approaches the coefficient of friction between the wheel and the rail the engine is on the point of slipping. By refer-

* A paper by E. M. Herr, Master Mechanic, Chicago, Milwaukee & St. Paul Ry., read at the May meeting of the Western Ry. Club.

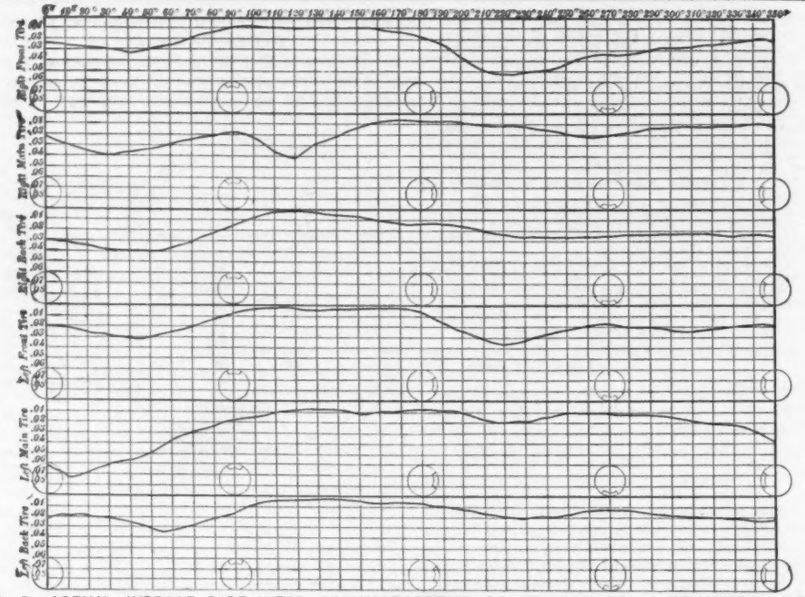


FIG. 5.—ACTUAL AVERAGE TIRE WEAR (IN HUNDREDTHS OF AN INCH) OF 53 TEN-WHEEL LOCOMOTIVES, C. M. & St. P. RY.; WEAR MEASURED AT POINTS 10° APART. (SMALL CIRCLES SHOW POSITION OF COUNTERBALANCE AT EACH POINT.)

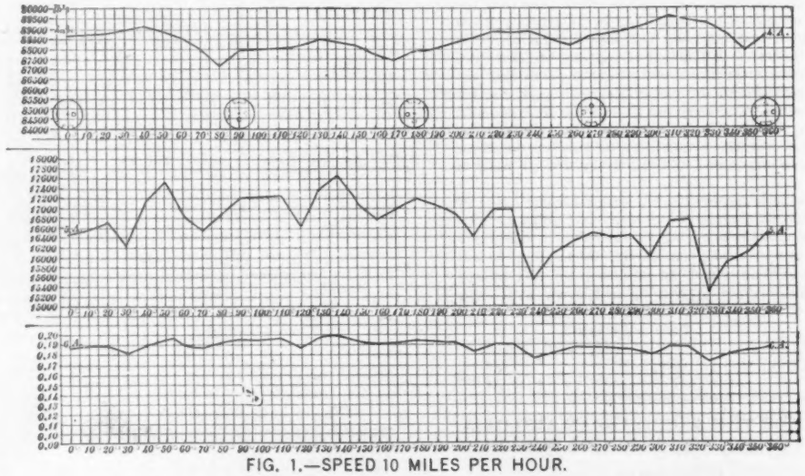


FIG. 1.—SPEED 10 MILES PER HOUR.

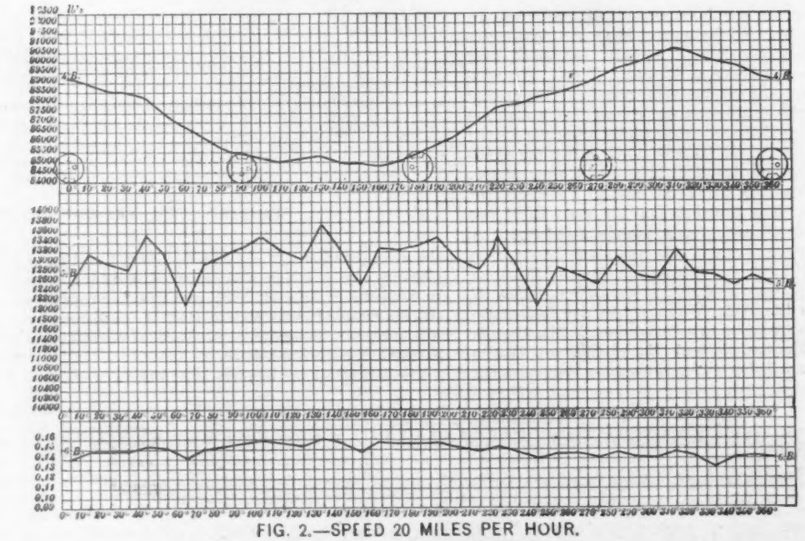


FIG. 2.—SPEED 20 MILES PER HOUR.

TOTAL WHEEL PRESSURE, TRACTIVE FORCE AND RATIO OF TRACTIVE FORCE TO WHEEL MILES PER HOUR.

Cylinder, 19 × 26 ins.; standing weight on drivers, 84,000 lbs. (Small circles on each diagram show position of crank ratie between the two, "coefficient of slip."—Computations from which the diagram is plotted were made for every actual one in every case.

ring to the diagrams on each of which the "coefficient of slip" is plotted at the bottom, the points where the tendency to slip is greatest are easily seen.

An inspection of curves 4A, 4B, 4C and 4D shows the wide variation in the total pressure on rail at speeds no higher than 40 miles per hour with an engine counterbalanced much better than many in regular service. The variation in the weight on the rail in the forward and back wheels is, of course, due entirely to the centrifugal force of the overbalance, and amounts, at 40 miles per hour, to a difference in total pressure on the rail of over 20,000 lbs. As this varies with the square of the speed, the importance of keeping the overbalance as low as possible is evident. This means reducing the weight of the reciprocating parts to the minimum, and adding to the counterbalance necessary to balance the revolving parts as small a part of the weight of the reciprocating parts as is consistent with a good riding and smooth working engine.

Curves 4A and 4B in diagrams 1 and 2 show the total weight on drivers to be always greater than the actual weight of engine. This, at first sight, looks anomalous, but is due to the angularity of the main rod always causing an increase of pressure on the main wheel. There is, of course, a corresponding upward pressure on the guides, reducing the weight on the track.

Curves 5A, 5B, 5C and 5D are interesting as showing the variation in the rotative or tractive force of the engine at various speeds and different points of cut-off. These indicate that this engine would pull more steadily at a speed of about 20 miles per hour than at either higher or lower speeds. The rotative force is, of course, affected by changes in the cut-off, but at high speeds the inertia of the reciprocating parts becomes the more important and materially affects the steadiness of the engine, regardless of the amount of steam worked. This is readily seen in any engine by an inspection of the diagram of a dynamometer car taken at high speed.

Curves 6A, 6B, 6C and 6D give the ratio of the rotative force to weight on rail, which I have followed Mr. Barr in calling the coefficient of slip. The maximum values here follow quite closely the maximum of the curve of rotative force, and it has its maximum value, for all speeds shown between 130 degrees and 140 degrees.

Diagram 5 shows the average irregular wear of each of the driving-wheel tires of 53 ten-wheel freight engines, obtained as follows:

Each pair of tires when placed in the lathe were rotated and the highest point of worn tread found. A bar of steel, with end cut off square, was placed in the tool rest and brought against the highest spot and securely clamped. The wheel is then rotated, if necessary, to bring the 0 deg.

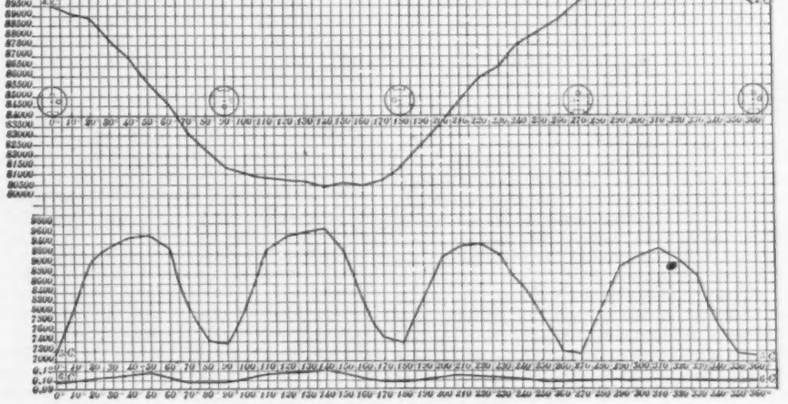


FIG. 3.—SPEED 30 MILES PER HOUR.

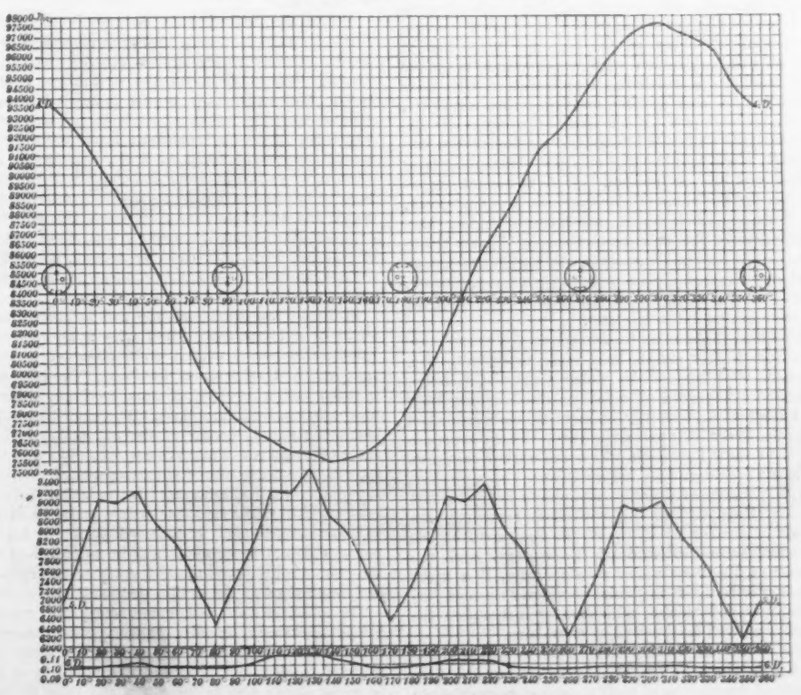


FIG. 4.—SPEED 40 MILES PER HOUR.

PRESSURE OF TEN-WHEEL LOCOMOTIVE, C. M. & ST. P. RY., AT SPEEDS OF 10, 20, 30 AND 40

and counterweights. Upper line shows total wheel pressures; middle line shows total tractive force; lowest line shows 10° of one revolution.) Note especially that the diagrams are condensed, so that the apparent base line is not the

point opposite the end of this bar. The depth of wear below the highest point is then measured in hundredths of an inch by inserting as many metal strips, each exactly 1-100th in. thick, between bar end and tire as the space will admit. Similar measurements every 10 deg. around the wheel are made. An average of measurements so made for 53 engines is plotted on diagram 5, each tire being considered developed on the datum line, and the amount of wear plotted therefrom. The diagrams of wheels on this sheet show clearly the position of each tire on its wheel.

We will consider first front and back tires only, as these wheels were overbalanced, the main wheels being underbalanced. An inspection of the diagram shows quite uniformly in both tires two locations of maximum wear, one beginning at about 165° and attaining a maximum at 220° or 230°, the other becoming pronounced at about 10° or 20° and attaining its maximum at about 50°. It will also be noted that both of these low spots are connected from 220° to 50° in the direction of rotation by a portion of the tire much more worn than that portion from 50° to 220°. In explaining the cause of this irregular wear it is necessary to bear in mind that there are two ways in which driving wheels are slipped. First, when the slipping is slight but distinctly noticeable, extending through but a small portion of a revolution; and second, when the hold on the rail is entirely broken and the wheels slip through a number of revolutions, usually turning with considerable velocity. There may be a third in which the wheels slip imperceptibly, but of this I have seen no satisfactory proof, but, on the contrary, considerable evidence that it does not exist.

Let us consider the first case when slipping is slight. This occurs almost without exception on heavy pulls at slow speed, being often seen when an engine is pulling hard on a hill, with the engineer trying to use sand sparingly, but alert "to catch her" at the first indication of "letting go." The beginning of slip must occur under these conditions at or near a maximum of the coefficient of slip. Referring to diagrams 1 and 2 we find a maximum value of the coefficient of slip at 50° and 140° at 10 miles per hour, and at 40° and 160° at 20 miles per hour. A slight slip here would cause a spot to wear following these points which the diagram shows. It is also noticeable that the amount of wear following 160° is much greater than that following 40°. The pressure of front and back wheels upon the rails explain the reason. In the former case the weight on rail is rapidly increasing, in the latter diminishing.

The effects of the second case of slipping are shown by the long worn spot, connecting the spots last considered. When the slipping occurs at speed, or the wheels let go and spin with considerable velocity, the variation of weight upon the rail should cause the greatest wear in that portion of the tire under greatest pressure. At speeds of 30 and 40 miles per hour respectively, the pressure on the rail from 160° to 30° varies from 12,000 to nearly 19,000 lbs., while from 30° to 160° it never exceeds 13,000 lbs., and falls at 90° to 100° to nearly 9,000 lbs. The latterpoint is also seen to be the least worn part of the tire.

As, of course, both wheels must slip together, the question may be asked, are there corresponding spots to these on the left tires one quarter back? Now 90° back of 40° is 310°, and on the left, front and back wheels at this point can be seen a slight spot; it is nearly worn out or merged into the long spot through this point, due to slipping at speed. Then again 90° back of 140° is 50° and here a decided spot is found on both left, front and back wheels.

With the main wheels the reasoning is the same, but as these wheels are underbalanced, the conditions are quite different from those found for front and back wheels. The spots caused by slight slipping near 40° and 140° should be found in these wheels as in the others, unless the accompanying condition of necessary pressure is absent. Computation shows from 16,000 to 17,000 lbs. at the former point, and from 14,000 to 15,500 at the latter. This is an ample pressure to produce abrasion, and an examination of diagram "5" shows decided spots near 40°, and lighter ones near 140°. Again computation shows the pressure to be greatest in the main wheels between 10° and 120°, where quite a decided spot is found. The wear of the tire on this pair of wheels is also modified by the pressure on the rail due to the angularity of the main rod which attains the maximum at 90° and 270°, and materially affects the wear at the latter point near which, on account of these wheels being underbalanced, the wear would otherwise be slightest.

The conclusion arrived at by Mr. Barr that pressures not exceeding 11,000 lbs. produce but little abrasion is confirmed by my observations, and the data herein shown.

In conclusion, to reduce the irregular wear of tires to a minimum: 1. The weight of reciprocating parts and consequently the overbalance in the driving wheels should be as light as possible. 2. As small a proportion of the reciprocating parts should be balanced as is consistent with smooth working machinery and good riding qualities. 3. Have a careful man at the throttle.

THE OSBORN AUTOMATIC REGISTER OR COUNTER.

The accompanying cuts represent the Elm City counting machine or register, made by G. E. Osborn & Co., of New Haven, Conn. Fig. 1 is a front elevation, and Fig. 2 is a view of the interior (the back plate being removed) showing the gearing. Motion is imparted by the up and down movement of the lever shown at the right hand. By the use of the steel springs to the wheels and the lightness of the moving parts the possibility is avoided of the wheels being revolved by the inertia due to a sudden stroke of the lever. This counter can therefore be driven by means of a pin on a revolving wheel, striking the lever, as well as by a direct pull and push from the machinery. The wheels, dials and case are of brass, and the lever, pawl, ratchet wheel,pinions and springs are of steel. The letters are black and are stamped upon the dials. The machine is very compact, requires no oil, and is guaranteed to run, with ordinary use, for five years. There are said to be some hundreds of these counters in successful use in flour-mills, bag factories and pumping stations, as well as on printing presses and other machines. They are adapted for the punches, screw and bolt machines, weighing and measuring machines, etc.

FIG. 1. THE OSBORN AUTOMATIC REGISTER.

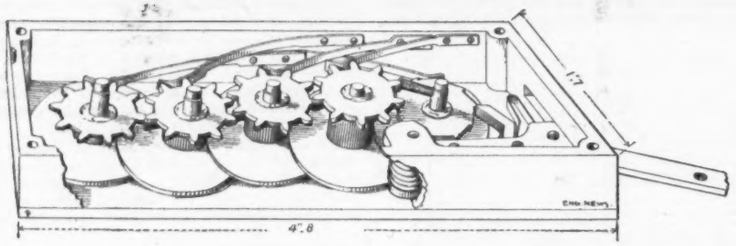


FIG. 2. GEARING OF AUTOMATIC REGISTER.

THE MICROSCOPICAL EXAMINATION OF POTABLE WATER.

There are only a few water-works engineers in this country who consider the study of the character of water supplies within their province. Most engineers very properly refer the matter to chemical or biological experts, or let it pass by without careful attention from anyone. Among the notable exceptions to the above is Mr. Geo. W. Rafter, C. E., of Rochester, N. Y. A recent book by Mr. Rafter entitled "The Microscopical Examination of Potable Water" is listed elsewhere in this issue under "New Publications." Some of the most instructive information in the book is abstracted below.

The first part of the book tells how to study the biology of a water supply. It describes the necessary working tools and the test methods of collecting water or organisms for examination from mains, streams or reservoirs.

In collecting samples from water mains for a general examination a single thickness of fine cotton cloth may be stretched over an ordinary cock, thus forming a filter. After a full flow for say two hours the cloth should be removed, turned wrong side out, and either dabbled in a small amount of water in a deep dish or washed off with a laboratory wash bottle.

In collecting from streams or bodies of water methods will vary with the objects which it is desired to secure. For fresh water algae the author states that all his collections have been made with a few bottles, a walking stick, a rake and such additional helps as could be improvised. A small iron or tin ladle with teeth on the circumference opposite the handle, with some means of lengthening the handle, is of use in securing masses of algae beyond arm's length. For intercepting floating masses of desmids a sieve is necessary. An iron spoon and a rake are of use in securing samples of mud along the edge or from the bottom of a stream body of water. Dipping nets are of use for securing entomostraca.

The examinations of water treated of by Mr. Rafter are limited to forms of plant or animal life which do not require special cultures for development. In other words, the bacterial organisms are not considered. In addition, the sanitary and economic phases of the subject are not treated in this volume, but are left for a subsequent one.

In studying water supplies from deep ponds or lakes, reservoirs, creeks or rivers the natural history of the water should be determined. Often the examinations should extend over a whole season, and in difficult cases over two or more seasons. Four distinct lines of investigation may be carried out, as follows: (1) A study of the environment, including the topography and geology of the drainage area, the number of inhabitants and their chief occupations. (2) A study of the physical properties of samples, in connection with which should be noted the depth from which the samples are taken, their temperature and specific gravity, color, turbidity, sediment, and odor. (3) A chemical analysis for dissolved and suspended albuminoid ammonia, free ammonia, nitrites, nitrates, chlorine, hardness, total solids and loss on ignition. (4) A biological examination for the plants Chlorophyceae, Cyanophyceae, Diatomaceae and Fungi, the latter including bacteria; also of the animals Crustacea, Vermes (Rotifera, etc.), Polyzoa, Infusoria, Rhizopods, Spongidae and miscellaneous; also amorphous organic matter. All of the biological examinations are made with the microscope, except of bacteria.

The first systematic examination of a water supply, Mr. Rafter states, was made in 1850 by Dr. Hassall, and was of the water supply of London, England. Accounts of other results between 1850 and 1880 deemed worthy of mention were published in 1865, 1870, 1879 and since 1880. These dates are given to show how little which the author considers of merit had been done before 1880.

The methods of different examiners are described by Mr. Rafter. The Sedgwick-Rafter method, the result of studies by Prof. W. T. Sedgwick, of the Massachusetts Institute of Technology, and the author of the book under consideration, is a great improvement upon methods previously in use, especially in determining with greater correctness the number as well as the kind of organisms.

The credit of having first used a quantitative method is given to Dr. H. C. Sorby, but the first published description of such a method is credited to Mr. A. L. Kean (Eng. News, March 30, 1889). The Sedgwick-Rafter method is a development, first by Prof. Sedgwick, and afterward by Mr. Rafter, of the method of Mr. Kean.

Mr. Kean in his method first inserted a plug of wire gauze in the foot of a funnel, and placed on this coarse sand to the depth of ½ in. (24 to 30 grains to the inch). A known quantity of water, say 100 cu. cm., was passed through the sand, after which the plug holding the sand in place was removed and 1 cu. cm. of distilled or freshly filtered water was thrown into the funnel by means of a pipette. The sand and intercepted organisms were thus washed into a watch-glass, the sand sinking to the bottom and leaving most of the organisms suspended in the water. A cell of 1 cu. mm. capacity was then filled with the water, the organisms in this cell were counted, and from this count the total number of organisms in the original sample was estimated. The amount of water actually examined by this method was so small that serious errors were likely to result, especially as the number of organisms found are multiplied by 1,000 to give the total for 1 cu. cm. An error of one in the count would make an error of 1,000 in the result, while some organisms might be entirely overlooked. If the number of organisms was very few a large number of samples would have to be examined to determine the number with any approach to exactness.

Prof. Sedgwick used the same method of filtration as did Mr. Kean, but distributed the whole 100 cu. cm. of water together with the sand over a cell of 20×50 mm. by about 2.5 mm. deep, the bottom of the cell being ruled into 1,000 squares, each 1 mm. in area. By taking pains to distribute the sand and water over the cell a fair result for the whole area could be obtained by counting say 20 squares and multiplying the result by 50, thus saving the long and tedious process of counting the organisms or 1,000 cells through the microscope. The objection to this method, Mr. Rafter states, is that the sand as well as the organisms pass into the cell. The finest grain of sand being much larger than any of the organisms, some of the latter are liable to be obscured and thus not counted.

The Sedgwick-Rafter method is as follows:

After the sand is placed in the funnel and lightly pressed with a glass rod, from 20 to 40 cu. cm. of freshly filtered water is run through it to insure thorough settlement. For ordinary samples of water 500 cu. cm. are pressed through the sand, but 1,000 cu. cm. may be used in case of very pure water. As the filtration is not so complete at the start the first 150 or 200 cu. cm. are passed through the sand a second time.

When the filtration is completed the sand is washed into a 5 or 6 in. test tube with 5 cu. cm. of freshly filtered water from a pipette. The tube is slightly shaken to clean the organisms from the sand. The sand sinks to the bottom, leaving the organisms in the water, which is turned into another test tube. Thus the organisms from 500 cu. cm. of water are concentrated in 5 cu. cm. After slight stirring to secure an even distribution of the organisms in the tube a 1 cu. cm. pipette is filled with the water and organisms, both of which are transferred to a cell 20×50 mm., exactly 1 mm. deep. The top of this cell is ground perfectly smooth, so that with a little practice a thick cover-glass can be floated to place without losing a drop of the water.

To count the organisms the cell is placed on the stage of a microscope, fitted with a micrometer so ruled as to cover, with a given objective and fixed tube length, 1 sq. mm. on the stage. The microscope is fitted with a mechanical stage having a millimeter movement in both directions. The count is made by beginning at one corner of the cell and going over the 1,000 squares in accordance with such a formula as will insure a count of squares from every part of the stage, thus eliminating the tendency to count contiguous squares or those where many or few organisms are present. If time will permit at least 50 squares should be counted, and in no case less than 20. By this improved method many more organisms are found than by the earlier methods.

The effect of light and temperature upon water is briefly discussed by Mr. Rafter. The chlorophylaceous and amylaceous plants require light as a primary condition of growth. The intensity of light in water grows less as the depth and color increase. So far as depth alone is concerned the intensity of light decreases as the distance increases. The color varies with local causes. Observations show that as the color of water increases the plant life decreases.

Temperature exerts a great influence upon the growth of plants. Ordinarily low temperatures reduce plant life, but some forms flourish in low temperatures. At depths where the temperature is practically constant throughout the year it appears that both plant and animal life flourish during the whole year.

At the close of volume 23 there is a bibliography of the books and topics bearing on the sanitary relations and biology of water supplies which the author considers of use in studying the subject.

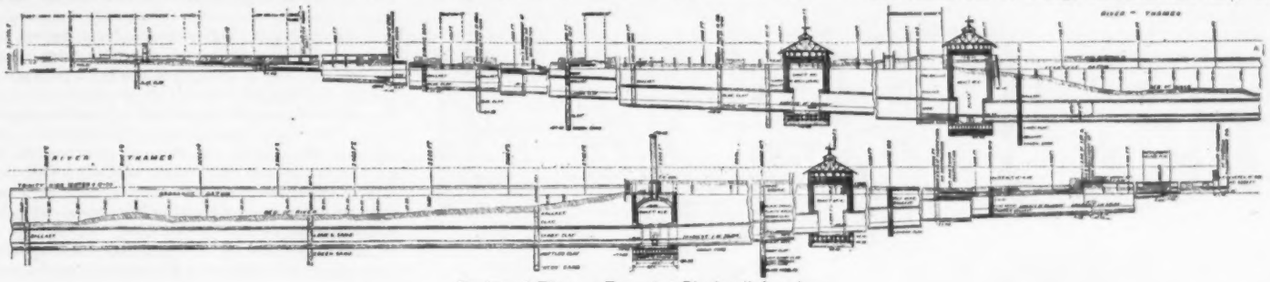
HIGHWAY TUNNEL UNDER THE RIVER THAMES AT BLACKWALL, LONDON, ENGLAND.

We have from time to time published notes in regard to the construction of a highway tunnel under the River Thames at Blackwall, in the eastern part of London. There is much need of means of communication between the districts on both sides of the river at this point, and various bridge and tunnel projects were presented. The London County Council decided in favor of a tunnel in consequence of the interference with navigation which would be caused by a bridge, and plans prepared by Mr. Alexander R. Binnie, M. Inst. C. E., engineer to the Council, have been approved and adopted. The act authorizing the carrying out of the work was passed in 1887. The following description and accompanying cuts are taken from "The Engineer," which paper considers that a bridge would have been preferable, and had plans for a bridge prepared, to show the feasibility, as stated in a note in our issue of April 2. The same paper also objected to the narrowness of the roadway and sidewalks (Eng. News, Nov. 28, 1891), 16 ft. and 3 ft. respectively, and this point seems very well taken.

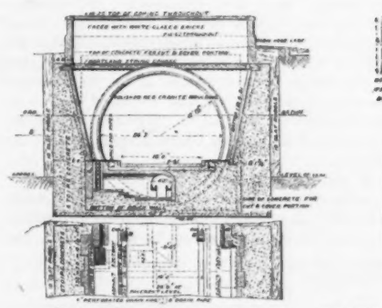
The contract for construction was let to G. & W. D. Pearson & Son, of London, whose bid was $4,355,000. The cost was estimated by the engineers at $400 per lin. ft. The scheme was reported upon favorably by Sir Benjamin Baker and Mr. Greathead. The tunnel will be lined with cast iron plates, bolted together by interior flanges, the arrangement being similar to that employed in the Hudson River and St. Clair tunnels (Eng. News, April 12 and Dec. 6, 1890), but there will be a brick lining inside the iron. The approach portions of the tunnel, which are built in open cut and afterward covered in, will have 18 ins. (four rings) of brickwork, with a backing of 8 to 1 Portland cement concrete, and 18 ins. of clay puddle, no iron lining being used on these portions. The open approaches are of concrete, backed by puddle, with brick facing and parapet walls. The roadway of the tunnel will be paved with granite blocks on 6 to 1 Portland cement concrete; below this will be gravel filling resting upon a bottom filling of 8 to 1 Portland cement concrete carried up to a width of 20 ft. between tunnel walls. The sidewalks will be paved with asphalt.

The tunnel is intended as a carriage and foot way, the carriage entrances being placed at about 2,550 ft. from the river on the north, and about 2,450 ft. from the river on the south side. It will be observed that means are provided for the entrance and exit of foot passengers at three or four vertical shafts, so that foot passengers will not necessarily have to go half a mile inland to get in or out of the tunnel. The shafts are to be 48 ft. inside diameter and 5 ft. in thickness. The tunnel will be a huge cast iron tube lined with brick, the inside diameter being 24 ft. 3 ins., and the outside 27 ft. The tunnel is not straight throughout its whole length, but is bent at the shafts, provision being made for this as shown by the sectional plans. The system of construction, of excavating, of advancing the segmental tube, and of grouting in the space all round it, is generally that of Mr. J. H. Greathead, as carried out in the City & South London Ry., and to be used for the Central London Ry. Means for ventilating are to be provided, and No. 3 shaft is for ventilating purposes. Special precautions are to be taken to secure tightness of the drains in the tunnel, and for the junction of the tunnel with the shafts. The specifications for the works, like the drawings, are made with minute attention to detail. These reflect great credit on the engineer of the works, and it must be hoped that the tunnel will prove more useful than there seems any reason to think it will.

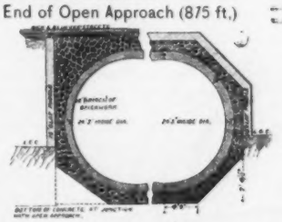
The contractor's responsibilities are considerable with respect to the removal, renewal and substitution of ex-



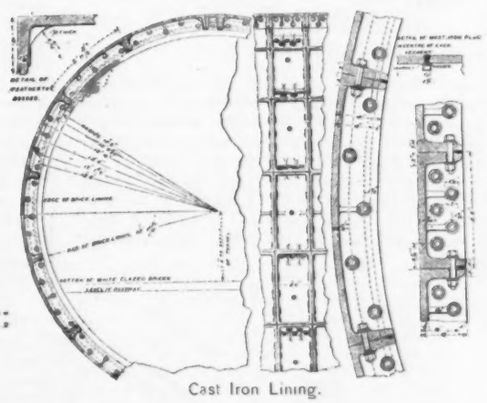
Profile of Thames Tunnel at Blackwall, London.



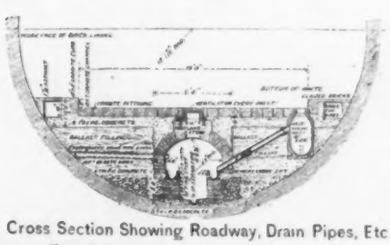
End of Open Approach (875 ft.)



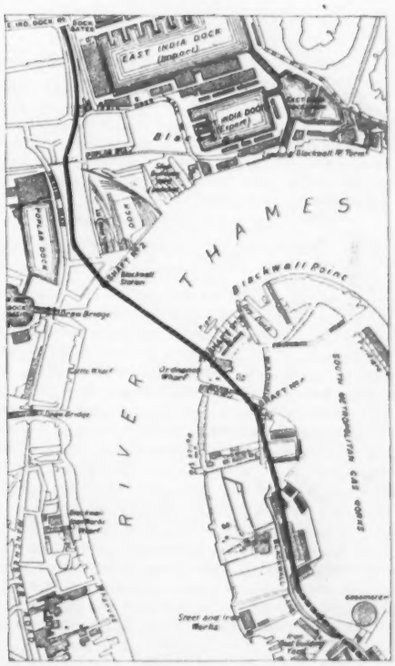
Cross Sections of Cut and Cover Portions of Tunnel.



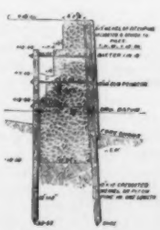
Cast Iron Lining.



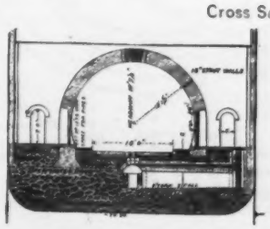
Cross Section Showing Roadway, Drain Pipes, Etc.



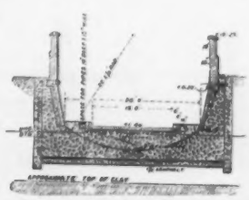
Map Showing Line of Thames Tunnel at Blackwall, London.



Section of River Wall.



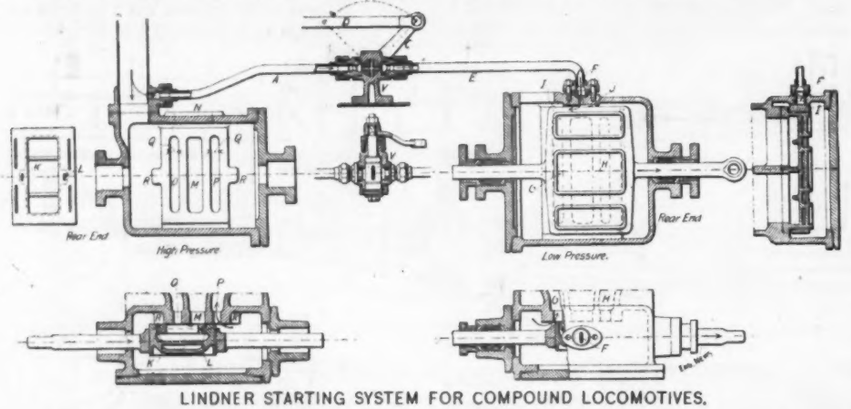
Section at Center of Shaft.



Section at 500 ft.

THE THAMES TUNNEL AT BLACKWALL, LONDON; Alexander R. Binnie, Engineer.

isting sewers, and the maintenance of existing river walls as at Ordnance Wharf. In the construction of 335 ft. on the south side and 436 ft. on the north side, the approach tunnel will have its top near the surface, so that these lengths may be made in open cutting, and covered afterward in the manner shown. The specification is very precise with regard to provision of sufficient compressed air and hydraulic machinery for the maintenance of sufficient pressure to keep out the water under somewhat considerable head when the Thames is at high water spring tides, and also for moving the shield. The bricks for the lining of the tunnel are to be specially made for the purpose of filling and fitting the cast iron rings and the internal flanges. The drainage of the tunnel during and after construction involves very extensive provisions with regard to the composition of concrete in retaining walls and elsewhere; these are generally mentioned in the drawings. The tunnel has a length of about 1,200 ft. under the river itself, and a total tunnel length of 4,465 ft., but the total length from entrance to entrance, including the open approaches, is 6,200 ft. It will be seen that the whole of the works comprise a very big undertaking, and must involve a very heavy demand upon Mr. Binnie's department.



LINDNER STARTING SYSTEM FOR COMPOUND LOCOMOTIVES.

THE LINDNER STARTING SYSTEM FOR COMPOUND LOCOMOTIVES.

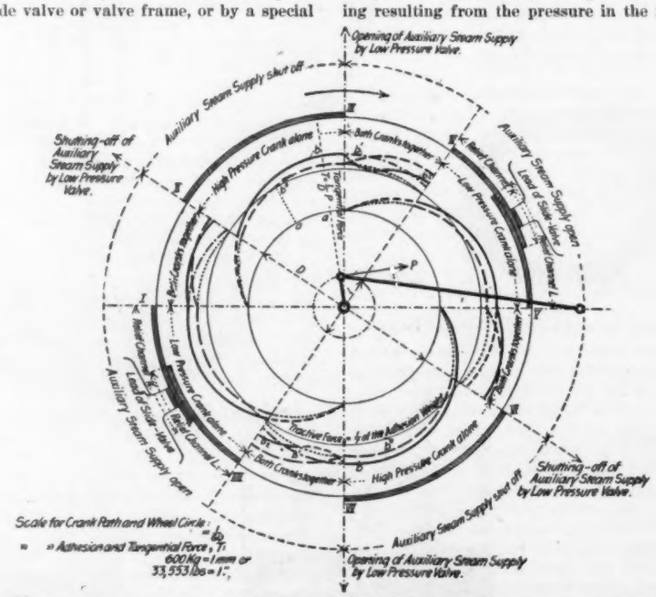
The Lindner starting system for compound locomotives is the invention of Mr. Robert Lindner, of Chemnitz, Germany, and is designed to enable the engine to exert its maximum tractive force at starting by automatic means, without requiring any special handling by the engineman. In a two-cylinder compound engine some special arrangement is necessary to increase the tractive force at starting, and the various means adopted for attaining this object are based upon the principle of leading live steam direct to the low-pressure engine for starting. This has been generally effected by working the compound engine temporarily as a non-compound engine, by means of an intercepting valve placed in the receiver, and in some cases obtaining by means of this valve an automatic opening and closing of the passages through which live steam passes direct to the low-pressure valve chest. In the Lindner system the desired effect is obtained without such interruption of the compound action, and without using any apparatus in the receiver, or any valve or contrivance requiring to be specially actuated by hand or automatically.

The system consists in leading auxiliary live steam to the low-pressure valve chest by means of a pipe, the supply depending upon the position of the low-pressure slide valve. The pipe is fitted with a four-way cock, the crank of which is connected with the reversing lever by means of a rod in such a manner as to partake of all movements of the lever. There are also small orifices cut in the high-pressure slide valve, by means of which, so long as the latter covers both the admission ports of its cylinder, there is communication from one side to the other of the high pressure piston. The auxiliary supply of steam is generally taken from the main steam pipe through the pipe (A). With engines having two high-pressure cylinders and one receiver common to both, as well as with express engines having large driving wheels and moderate tractive force, the steam is taken from a pipe in the throttle valve in such a way that the admission through the main steam pipe commences when the throttle valve lever is first moved, while the admission of the auxiliary steam supply only begins when the lever has reached about its middle position. The main steam pipe having then been half opened, there is consequently full steam pressure in the high-pressure valve chest, and when the high-pressure piston has to exert a starting force, it will be already under full pressure of steam before the auxiliary steam pipe begins to open.

A continuous admission of auxiliary steam to the low-pressure valve chest is only possible when the reversing gear, to which the four-way cock (B) is connected by the crank (C) and rod (D), is put in full forward or full backward gear. When the reversing gear is set for a cut-off, at fully 70% of the stroke, the cock (B) shuts off the auxiliary steam supply. On starting, therefore, the reversing gear must be set full forward or backward in the same way, as with a simple engine. The auxiliary steam is admitted to the low-pressure valve chest by the pipe (E) in such a way that the inlet orifice (F) is opened or shut simultaneously with the opening and shutting of the steam ports (G) and (H) by the slide valve. This is effected by means of a friction plate (I) on the slide valve or valve frame, or by a special slide valve attached to the valve rod of this cylinder, the result being attained by having the projection (J) of the friction plate equal to the outside lap of the low-pressure valve. The auxiliary supply of live steam is thus only led to the low-pressure valve chest when it is required—that is to say, when the cranks are in such position that the low-pressure piston has to do the starting. There is no auxiliary supply, and consequently no back pressure on the high-pressure piston, whenever the latter has to start the engine unaided. The movement of setting back the reversing gear, commonly performed by the engineman as soon as the engine has started, closes the cock of the auxiliary steam pipe, supposing the engine to be working with an ordinary cut-off of 70%. Should the engine, however, be run in full gear in any exceptional case, the auxiliary steam passing to the low-pressure cylinder will assist the working of the engine.

The small relief openings (K) and (L) in the high-pressure valve constitute a communication from the exhaust port (M), and therefore from the receiver (N) to the steam ports (O) and (P) as soon as the latter ports are both covered by the valve, and when consequently there can be no admission of live steam to the cylinder. The bars (Q) of the high-pressure slide valve are the same width as the steam ports (O) and (P), so that live steam from the boiler cannot pass out of the valve chest to the exhaust passage and the receiver. The auxiliary steam, however, which is admitted into the low-pressure valve chest and so into the receiver, equalizes the pressure on both sides of the high-pressure piston through the passages (K) and (L) as soon as the valve covers the ports (O) and (P), and in this way all back pressure on the high-pressure piston is prevented whenever the low-pressure piston has to start the engine alone. The lugs (R) on the valve seat close the openings (K) (L) in the extreme positions of the valve. The area of (K) and (L) is about 1-1500 that of the high-pressure piston, and they only act at the moment of starting; that is to say, when the valve is not moving, as already described. In the case of a locomotive in motion, it is said that numerous indicator diagrams taken at the lowest possible speeds with these passages open, and also with them purposely closed, show that the amount of expansion steam passing through them to the receiver during the period of expansion is inappreciable, and that the passage of compression steam to the receiver is only more observable in consequence of the small extent of the compression space. The result of both is an inconsiderable increase of the pressure in the receiver, as well as a more marked reduction of the cushioning.

In a two-cylinder locomotive the high-pressure slide valve must have a rather considerable inside lead, in order to reduce the large amount of cushioning resulting from the pressure in the receiver, and it is therefore claimed that the passages (K) (L) produce a favorable effect while the engine is running, the benefit of which is greater the earlier the cut-off. The reduction in the cushioning resulting from these openings diminishes, for a given suitable amount of compression, the extent of inside lead necessary for the slide valve, and the period of expansion on the high-pressure side may thus be prolonged. In the event of any breakage, the engine can be run with the low-pressure cylinder alone by the auxiliary steam supply, the high-pressure side being uncoupled and secured and the low-pressure slide valve set in


Opening of Auxiliary Steam Supply by Low Pressure Valve.
Auxiliary Steam Supply shut off
Shutting-off of Auxiliary Steam Supply by Low Pressure Valve.
High Pressure Crank alone
Both Cranks together
Relief Channel
Lead of Slide Valve
Low Pressure Connections
Auxiliary Steam Supply open
Low Pressure Crank alone
Tractive Force = ⅓ of the Adhesion Weight
Both Cranks together
High Pressure Crank alone
Shutting-off of Auxiliary Steam Supply by Low Pressure Valve.
Auxiliary Steam Supply shut off
Opening of Auxiliary Steam Supply by Low Pressure Valve.
Scale for Crank Path and Wheel Circle: 1" = 1 ft.
1" = Adhesion and Tangential Force, 1" = 600 Kg = 1 mm or 33,553 lbs = 1".

STARTING DIAGRAM OF NON-COMPOUND AND LINDNER COMPOUND LOCOMOTIVES.

mid-gear. In the same way the high-pressure cylinder can work alone, when the low-pressure side of the engine has been uncoupled and secured and the low-pressure slide valve pushed so far outward that the exhaust steam from the high-pressure cylinder can escape direct into the air.

The system can be adapted to all kinds of locomotives and all kinds of reversing gears, and with both slide and piston valves. It can be used for compound engines with more than two cylinders. When two high-pressure cylinders and one common receiver are employed, the auxiliary steam is led by a pipe from the throttle valve. When one low-pressure cylinder is employed, or two low-pressure cylinders with separate receivers, the auxiliary steam is led through the pipe (E) to the low-pressure valve chest, but in the case of two low-pressure cylinders and one common receiver, it is led simply through the pipe (A) to the receiver.

The conditions which occur on starting a two-cylinder non-compound express engine with its cranks at an angle of 90° are shown by the long dash and small dotted lines in the accompanying diagram, giving the tangential forces developed in the various crank positions and transmitted to the periphery of the driving wheels. The heavier full lines and short dash lines show similar forces for a two-cylinder compound locomotive. It will be noticed, however, that the tractive force is taken at 1-7 of the weight on the driving wheels, whereas in this country it is generally taken at 1-4 of that weight, so that the tractive power would be 6.89 tons instead of 3.69 tons. The pressure lines (b) of the compound are marked (b^1) where the auxiliary steam is taken from the throttle, and (b^2) when it is taken from the main steam pipe. The pressure lines of the non-compound are marked (b°). The engines to which the diagrams refer are of similar construction except in regard to the compounding. The leading dimensions are as follows:

		Non-comp.	Comp.
Diam. of h. p. cylinder	(d)	17.32 in.	17.32 in.
" " l. p. "	(d^1)	.....	25.59 "
Stroke of cylinders	(dl)	23.62 in.	24 62 "
Ratio of cylinder areas,		.....	1: 2.18
Diam. of driving wheels	(D)	6 ft. 1¼ in.	6 ft. 1¼ in.
" " crank path	(l)	23.62 in.	23.62 in.
Boiler pressure	(p)	142.2 lbs.	170.6 lbs.
Max. press'e in receiver	(p^1)	.....	78.22 lbs.
Adhesion weight	(Q)	27.56 tons.	27.56 tons.
Tractive power	(Z)	3. 9 "	3.69 "

The following explanation of the diagram is taken from a pamphlet descriptive of the Lindner system:

In regard to the non-compound diagram, the tangential forces transmitted to the wheel periphery, when starting from the several crank positions, are shown as rays lines (abo),running radially to the wheel circle (a). The crank positions I and V, correspond to the dead points of the leading crank, the positions VII and III to those of the following one. The admission of steam begins without any reference to the linear advance of the slide valves at the dead points (since this advance does not affect the starting impulse), while the cut-off at 80% of the stroke takes place at the positions IV and VIII of the leading crank, and II and VI of the following one. In the crank position of the phases II—III, IV—V, VI—VII, and VIII—I, only one piston is exerting force, and the tangential force increases with the progressive crank positions from its minimum amount, which is less than the adhesion, until it soon exceeds the latter. In the crank positions of the phases I—II, III—IV, V—VI and VII—VIII, both pistons work together, the leading one with slowly diminishing, and the following one with rapidly increasing, power, so that the total tractive force considerably exceeds the adhesion, until, at the end of the phases, it suddenly drops to its minimum value, which is less than the adhesion. It must be here remarked that the diagram only holds good for the tractive forces which are developed during the starting of a locomotive from a position of rest, and not for those developed while running. In a running diagram, the steps of the line of tractive force are equalized, owing to the expansive working of the steam, and the diagram becomes nearly a circle.

The diagram for the non-compond locomotive shows clearly that a two-cylinder compound engine, having its low-pressure crank set at a right angle with the high-pressure one, cannot start, without the use of some special auxiliary contrivance,whenever the high-pressure slide valve covers both its team ports—that is to say, during the crank positions IV—V, and VIII—I. Similarly it will be seen that during the positions I—II and V—VI, there would only be developed an insufficient tractive force, gradually increasing from zero. This shows the necessity for some special arrangement to obtain any starting effort with a compound engine in the crank positions above mentioned, and also that this effort, when a compound locomotive is being started by only one piston, must in no case be smaller than that of a non-compound one, and, when both cranks are starting together, must never be less than the adhesion.

It must be specially noted that, where the stroke of the pistons and the diameter of the wheels are the same in both engines, a compound locomotive can only produce the same effect as a non-compound one, when either the steam pressure or piston area on the high-pressure side is 20% greater than in the case of the non-compound engine. The ratio of the areas of the high and low-pressure pistons does not affect this. This circumstance, which is generally not sufficiently taken into account in designing a compound locomotive, is due to the conditions of pressure which occur in the case of such an engine.

If the starting power of the compound locomotive with Lindner's gear be studied in the several crank positions, it will be found that in the crank positions II—III and VI—VII, the starting is done by the high-pressure piston alone, with a force which increases with the travel of the crank and without any back pressure whatever. This is the case during these positions, whether the starting steam is led from the main steam pipe or from the regulator, because the opening (F), for the admission of auxiliary steam into the low-pressure valve chest and thus into the receiver, is then closed by the low-pressure slide valve. In positions IV—V and VIII—I, the starting is done by the low-pressure piston alone, with a force also increasing as the crank moves on, and of at least the same magnitude as in the positions II—III and VI—VII. The high-pressure piston is at the same time relieved by means of the two small orifices (K) and (L) in the high-pressure slide valve and also for the given short portion of the crank movement by means of the inner lead (W) of this valve.

In positions I—II and V—VI, the chief part of the starting is done by the low-pressure piston with great force, (which, however, slightly diminishes in proportion to the progressive crank positions), and also at the same time by the high-pressure piston with a small force which increases with the travel of the crank; the total force obtained is thus the sum of the forces of both pistons. The pressure in the receiver is here, in the case of the high-pressure piston, acting against the boiler pressure, and this causes an advantageous reduction of the starting force which in this case is greatly in excess of the adhesion. In positions III—IV and VII—VIII, the conditions differ according as the auxiliary steam is led, as already described, from the regulator, or simply from the main steam pipe. If from the regulator, then, previous to the opening of the auxiliary steam pipe by the movement of the latter, the starting is done by the high-pressure piston alone with great force, which slightly diminishes as the crank moves on, as indicated by the line of pressure (b-1). If the auxiliary steam is led from the main steam pipe, then, in addition to the high-pressure piston, the low-pressure one also exerts a slight starting force, which, however, increases with the travel of the crank. The pressure gradually developed on the low-pressure piston, works, however, in this case, obstructively on the high-pressure one, but as the high-pressure crank is then in the most favorable position, the starting is quickly done by it before any considerable pressure can be developed in the receiver, so that the net starting force is always amply sufficient and in excess of the adhesion, as indicated by the line of pressure (b 2), which in its position cannot be given mathematically correctly, but is here unfavorably drawn.

A comparision of the starting diagram of the compound locomotive with that of the non-compound, shows clearly that a compound engine with Lindner gear possesses, as described, a power of starting which in the lower stages is greater, and altogether less variable than that of a non-compound engine of the same tractive power; and that all the conditions involved in the problem of starting are completely fulfilled by the Lindner system.

The first Lindner compound locomotive was put on the Saxon State Railways in 1887, and having been found to cause no difficulties in handling the traffic, and to show a saving of 20% in fuel consumption as compared with simple engines of the same type, about 150 of these engines have been gradually introduced on the Saxon State Railways, Bavarian State Railways and other German lines. There are now over 300 locomotives fitted with this system in service and under construction on various railways in Germany, Russia, Austria, America and the Dutch colonies. On the Saxon State Railways seven simple engines have been converted into compounds on the Lindner system, and on the same railways there are two standard gage and ten narrow gage Lindner compound engines of the Meyer type, with double driving trucks, the rear truck carrying the two high-pressure cylinders and the forward truck the two low-pressure cylinders. In these engines the connecting pipe between the high and low pressure cylinders constitutes the receiver, and the standard gage engines have the low-pressure cylinders jacketed with live steam from the boiler. The auxiliary steam supply is taken from the throttle and admitted through the starting cock to the receiver. When switching or drawing light trains the throttle is only half open, and the high-pressure cylinders work alone and without any back pressure. The engines burn coal and lignite, and effect a saving in fuel consumption of 15 to 20% when properly designed. They have a starting power equal to that of simple engines, and start easily. One advantage of this system is its simplicity, the main steam passages remain entirely clear, and the gear is self-acting, being operated by the engineman by the movement of the reversing lever, without any valves or other parts having to be moved specially by hand or automatically. Hope & Co., St. Dunstan Hill, London, England, are agents for the Lindner system.

A remarkable suit has recently been decided in a San Francisco court. For years the companies which own the mines on the Comstock lode, although working ores of great richness, have paid no dividends to their stockholders. The ore when mined is delivered to a milling company, which is supposed to extract the bullion and return it to the company, charging it for the work of milling. The milling companies which work the Comstock ores are controlled by the same parties which control the mining companies; and they have so manipulated affairs that the milling companies have made all the profits, and the stockholders of the mining companies have had to submit to assessments instead of receiving dividends. The suit brought by M. F. Fox and other stockholders of the Hale & Norcross Silver Mining Co. has resulted in the proof of conspiracy, the damages for which were assessed by the court at $1,011,835, and judgments were rendered against ten directors of the company, to recover this amount. It is of interest to note that one of the principal owners of the Nevada Mill & Mining Co., which defrauded the Hale & Norcross stockholders, is U. S. Senator John P. Jones. Our contemporary, the Engineering and Mining Journal, says:

"The Comstock Milling Co., which has done a like service (defrauded) for the still patient stock-holders of the Consolidated California & Virginia Co., are United States Senator John P. Jones, John W. Mackey and James L. Flood. The only reason Senator Jones was not specifically included in the indictment and verdict in the Hale & Norcross case is that he carefully kept out of reach of the court. His guilt is that of the chief conspirator, and the injury he has done mining is increased by the disgrace to the country which His presence in the United States Senate brings. Surely some honorable Senator who seeks to promote or maintain the dignity and good name of the Senate will call the attention of his fellow Senators to the shame of having one with this record as a member.

The sale of the Housatonic R. R. to the New York, New Haven & Hartford R. R. Co. has been announced. This is one of the most important railway deals which have been consummated in New England for many years as it not only gives the New York, New Haven & Hartford R. R. Co. an important and valuable property but it puts an end to the expensive and scandalous conflict between the two companies in the Connecticut Legislature over the question of building a rival line to New York City. In brief, the purchasing company acquires 189.5 miles of railway line and valuable terminals at Bridgeport and New Haven, Conn., making the total mileage of its system 687 miles, and, with the exception of the New York & New England R. R. and the New London & Northern R. R., giving it control of practically the entire railway mileage of the State of Connecticut. The negotiations were carried out by J. Pierpont Morgan and Wm. Rockefeller, but no details of the purchase are yet given out.

Tests of the amount of steam used by Westinghouse airbrake pumps were recently made on the Southern Pacific Ry. A pump attached to the locomotive of a local passenger train made 6,607 double strokes in running from Sacramento to Oakland, 85 miles, using 806 lbs. of steam. Another pump on the locomotive drawing the overland express train from Oakland to Sacramento, made 6,745 strokes, and used 823 lbs. of steam. This indicates an average consumption of about 9½ lbs. of steam per mile.

The Tide Tables for the Atlantic Coast of the United States, together with 206 Stations on the Atlantic Coast of British America, for the year 1893, published by the U. S. Coast and Geodetic Survey, are now ready for issue, and copies can be obtained at the agencies of the Survey in this city, or by addressing the Office at Washington. Price, 25 cents.

The Michigan road law provides that users of wide wheel tires are entitled to a rebate of half their road tax.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

HUNTINGTON & BROAD TOP MT.—It is stated that this company is making arrangements to extend several of the branches leading to the coal fields.

MANISTEE & NORTHEASTERN.—The grading is completed on the extension to Traverse City, Mich., and tracklaying is in progress. It is expected to have the road opened for traffic during the present month.

INDIANA, ILLINOIS & IOWA.—The engineers of this company are making a survey of the proposed extension from Knox to Plymouth, Ind., about 15 miles. It is announced that the surveys will be continued from Plymouth to Goshen, Ind., about 38 miles further.

NEW YORK CENTRAL & HUDSON RIVER.—Preparations are being made to commence work at once on the Gouverneur & Oswegatchie R. R., from Gouverneur to Edwards, N. Y., about 12 miles. The object of the road is to give an outlet for the pulp and talc mills along the Oswegatchie River and to open up a new portion of the North Woods for tourists. The general contractors are Moffett, Hodgkins & Clarke, of Syracuse, N. Y.

OHIO SOUTHERN.—It is stated that surveys will soon begin for the proposed line from Springfield to Lima, O.

WESTERN NEW YORK & PENNSYLVANIA.—This company is renewing its entire equipment of bridges with new steel structures. A contract has been made with the Pencovd Bridge Works, of Philadelphia, for twelve steel bridges to be put up this summer. Two will be built on the Buffalo division, one near Franklinville and the other near Sizerville. Three will be built on the Rochester division, one at Tuscarora, one at Portage and the other at Fillmore. The Pittsburg division will have seven, located at Pioneer, Titusville, Sugar Run, Quaker Bridge, Red House, Corydon and Kinzua. These are all destined to replace wooden bridges. Last year seven new ones were put in, of which two were at Sizerville, two Tuscarora, and one each at McClintock, Sherman and Clymer.

PHILADELPHIA & READING.—W. G. Yetter, Div. Supt., Catawissa, Pa., writes us that 20 men are at work on the belt line at Bloomsburg, Pa. The total projected length of the line is 2.34 miles and of this distance 1.17 miles are under construction, upon which ½ mile of track has been laid. The maximum grade is 0.63%, and the maximum curve is 20°. It is expected to have the portion now under construction completed by July 1.

JOHNSONBURG & BRADFORD.—The contractors, Brendlinger, Nearing & Kelley, of Bradford, Pa., have a force of 1,000 men at work on this line from Howard junction to Mt. Jewett, Pa., 20 miles. It is expected to begin tracklaying about Aug. 15, and to have the line completed by October, 1892. Ch. Engr., J. M. Floesch, Bradford, Pa.

BUFFALO, ROCHESTER & PITTSBURG.—Geo. S. Good & Co., of Lock Haven, Pa., have secured the contract for building 16 miles of the extension to connect with the Beech Creek at Clearfield. The work has already been commenced and will be pushed vigorously. Their work extends from Clearfield along the Susquehanna River and Anderson Creek.

Projects and Surveys.

SLACKWATER CONNECTING.—Chartered in Pennsylvania to build a railway 1-mile long in Allegheny Co., Pa.

BEAVER FALLS.—A company has been organized to build a railway three miles long in the vicinity of Beaver Falls, Pa.

NEW YORK, CANADIAN PACIFIC.—The Albany "Journal" says: "The engineer corps of the New York Canadian Pacific Ry. Co. has finished its survey from Schenectady to Newark, N. J. The right of way has been secured for over 90 miles, and as soon as the engineers get the maps and profiles ready, which are being made by George Goet, the road will be placed under contract. The Hon. J. H. Ramsey has a syndicate that will take the bonds and build the road."

Southern.—Existing Roads.

ST. CLOUD SUGAR BELT.—Local papers state that the project of extending this road from Narcossee to Orlando, Fla., about 24 miles, is assuming definite shape.

BRUNSWICK, WESTERN & SOUTHERN.—About 6 miles of the grading have been completed on the 30-mile section of the line between Wilmington and Southport, N. C. Ch. Engr., Walter C. McCrea, Wilmington, N. C.

MIDDLE GEORGIA & ATLANTIC.—It is reported that this company has executed a mortgage for $376,000 on the completed portion of its road from Eatonton to Machen, Ga., to obtain funds for construction purposes.

NASHVILLE, CHATTANOOGA & ST. LOUIS.—The proposed extension from Huntsville to Hobbs Island, Ala., noted last week, is 14½ miles long.

LOUISVILLE & NASHVILLE.—The engineers of this company have made an examination of the ground at Florence, Ala., for the site for a bridge across the Tennessee River. It is stated that owing to a failure to make satisfactory arrangements for the transfer of its freight at this point, it will build a new bridge.—It is stated that after an examination of the route of the proposed branch from Worth to Owenton, Ky., the officials of this company have about decided not to build it.

TAVARES, ATLANTIC & TAMPA BAY.—A press dispatch states that construction has been commenced on the section of this railway from Tavares, Fla., to Villa City. Ch. Engr., Geo. O. Butler, Tavares, Fla.

BRISTOL, ELIZABETHTOWN & NORTH CAROLINA.—About 200 men are now at work between Bristol and Elizabethtown, Tenn. It is expected to have this section of the line in operation by July 15.

TENNESSEE MIDLAND.—This company has filed a mortgage for $2,700,000 of bonds, the proceeds of which are to be used in building an extension to Nashville, Tenn.

Projects and Surveys.

FLORIDA-KEY WEST RY. & BRIDGE CO.—Chartered in Florida to build a railway through Monroe and Dade counties, 175 miles long. Among the incorporators are Sewell P. Hayes and Isaac A. Stewart, of De Land, Fla.

UNAKA & NOLACHUCKEY.—The projectors of this road report that the prospects for its construction are very favorable. The Nashville, Louisville & Atlantic Construction Co. has made an offer to build the line and it is probable that it will be accepted.

NORFOLK, WILMINGTON & CHARLESTON.—The three companies chartered under this name in Virginia, North Carolina and South Carolina, have been consolidated under the same name, and the following officers have been elected: Pres., John C. McNaughton, Philadelphia, Pa.; Vice-Pres., Andrew C. Gaddis, Charleston, S. C.; Treas., R. Duncan Harris, New York, N. Y.; Gen. Man., Chambers H. McKibbin, Philadelphia, Pa., and Secy., Carroll Forster, Philadelphia, Pa. At a meeting of the directors held June 8 the contracts made by the several companies before consolidation, with the Carolina Construction Co., were ratified and confirmed by the new company. It was decided to at once draw up the mortgage papers and issue the mortgage amounting to $6,000,000 on the main line of the road between Norfolk and Charleston. It is expected that construction will begin within a short time.

FLORIDA COAST & GULF.—Chartered in Florida to build a railway from the St. John's River, near Jacksonville, Fla., to the Gulf coast at Tampa, Fla., 325 miles. Among the incorporators are: John Bushnell, Plainfield, N. J.; W. A. Harris, of Brooklyn, N. Y.; and L. R. Dyer, of New York City.

CHERRY RUN & POTOMAC VALLEY.—Chartered in West Virginia to build a railway from Harper's to Cherry Run, W. Va., through Jefferson, Berkeley and Morgan counties, W. Va. Among the incorporators are Thos. M. King, of Baltimore, Md., and I. E. Auld, of Martinsburg, Va.

Northwest.—Existing Roads.

CHICAGO, MILWAUKEE & ST. PAUL.—A press dispatch from Milwaukee, Wis., states that this company has let the contract for building an extension from Sidnaw, Wis., to Ford Siding, a point on the main line of the Milwaukee & Northern R. R., 24 miles north of Iron Mountain; a distance of 47 miles, to McIntosh Bros., of Milwaukee, Wis. It is stated that the contractors will put a force of 1,200 men to work at once.

CALGARY & EDMONTON.—Only about eight miles more of the extension south to Fort McLeod, N. W. T., remain to be graded. Tracklaying is expected to begin about the middle of this month, and the line is to be completed as rapidly as possible.

Projects and Surveys.

MONKATO & NORTHWESTERN.—The surveys for this road have reached a point near Lakeville, Minn., northwest of Monkato, Minn. The line, as surveyed, passes through Kasota, Cleveland, Le Sueur Center, Wesley and Newmarket. Ch. Engr., F. D. Woodbury, Mankato, Minn.

Southwest.—Existing Roads.

AUSTIN & NORTHWESTERN.—The extension from Fairland to Llano, Tex., 27 miles, has been completed, and was opened for traffic June 18.

MISSOURI PACIFIC.—Local papers state that surveys are in progress for an extension from Bagnell, Mo., to Batesville, Ark.

NEW ORLEANS, ARKANSAS & KANSAS CITY.—This company has been organized to build a railway from Morgan City, La., to Kansas City, Kan., and will absorb the Stuttgart & Arkansas River R. R., now completed from Stuttgart to DeWitt, Ark. It is stated that an extension from Stuttgart to Hazen, Ark., about 20 miles, will be built at once.

Projects and Surveys.

ROCKPORT & SUBURBAN.—Surveys have been commenced for this railway from Rockport to Harbor Island, 20 miles.

PAN AMERICAN.—Reports from Victoria, Tex., state that tracklaying is making rapid progress from that place south.

HOUSTON BELT.—Bids have been received for building the first section of 10 miles of this proposed belt railway at Houston, Tex., and contracts will probably soon be let.

Rocky Mt. and Pacific.—Existing Roads.

UNION PACIFIC, DENVER & GULF.—Surveys are in progress for an extension of the Beshoar branch, from Beshoar, Colo., to the Gray Creek mines, about 3 miles.

GREAT NORTHERN.—It is stated that this company will abandon the attempt to build the extension from Neihart to Castle, Mont., recently surveyed, on account of the heavy grades, and that another line will be surveyed.

Projects and Surveys.

SAN FRANCISCO & ATLANTIC.—It is stated that this company will soon be chartered in California to build a railway from San Francisco to Los Angeles, Cal., 485 miles. A press dispatch says: "It is given out that this line will be in process of construction within 60 days, and that it will be constructed by Eastern capital, and that while it has friendly relations with the Atchison, Topeka & Santa Fe R. R., it is an independent line. Surveys are completed from San Francisco to Visalia, Cal., and a preliminary survey has been made from Visalia to Kramer, Cal."

Foreign.

MEXICAN SOUTHERN.—The grading is now about completed between Tecomavaca and Oajaca and tracklaying is now in progress.

MICHOACAN SOUTHWESTERN.—The maps and plans submitted by Messrs. Dennie and Marshall for the construction of the Michoacan Southwestern R. R. have been approved by the Department of Public Works. Work will be commenced June 14.

ELECTRIC RAILWAYS.

BRIGHTON, N. Y.—The Brighton & Bensonhurst Electric Ry. Co. has been organized to control the Sea Beach & Brighton Ry. Co. Pres., Hy. W. Slocum, Brooklyn, N. Y. Capital stock, $250,000.

SING SING, N. Y.—A franchise for 50 years has been granted to the Ossining Surface Ry. Co. The company will not make any payment to the city for the first 25 years.

NEW BRUNSWICK, N. J.—An electric railway to Somerville is projected by Dr. Price and others.

BALTIMORE, MD.—The Lake Roland Elevated Ry. Co. has awarded a contract to the Duplex Ry. Co., of New York, for tracklaying, and to the Thomson-Houston Electric Co., of Boston, Mass., for electrical equipment. The work is to be completed within 90 days.—The City & Suburban Ry. Co. has been formed by the consolidation of the Baltimore & Hampden, Union, and Highlandtown & Point Breeze street railways. The new company will control 61 miles of track, and will operate the greater part by electricity. The capital stock is $3,000,000.

NEW COMPANIES.—Chester & Darby Electric Ry. Co., Chester, Pa.; $50,000; C. H. Warren, Fall River, Mass.; F. S. Holmes, Brooklyn, N. Y. Portage Creek & Rich Valley Ry. Co., Liberty, Pa.; $30,000; 9 miles; Pres., H. B. Parkhurst, of Elkland. College Hill Marginal Ry. Co., Beaver Falls, Pa.; $30,000; Pres., John C. Whitlaw. Electric Railway Co. of the U. S., New York, N. Y.; Cyrus W. Field, Stephen J. Field, Caphas Brainerd and P. P. Harris.

ELEVATED RAILWAY.

CHICAGO, ILL.—Elevated Suspension Ry. Co.; $4,000,000; Lysander Johnson, G. J. Ladd and H. A. Buell.

HORSE AND MOTOR RAILWAYS.

NEW YORK, N. Y.—The Houston, West St. & Pavonia Ferry Ry. will build a single track extension to connect with an extension to be built by the Chambers St. & Grand St. Ferry Ry.

CHICAGO, ILL.—Chicago & Suburban Rapid Transit Co.; $5,000,000; J. H. Ashby, C. F. Caldwell and M. J. Tierney.

HIGHWAYS.

NEW YORK, N. Y.—The Watervliet turnpike road between Albany and Troy is to be macadamized and improved by the Albany Ry. Co.

PENNSYLVANIA.—A macadamized road, three miles long, from Merchantsville to Colestown is proposed by the Board of Freeholders of Camden Co.

ILLINOIS.—At a meeting in Freeport, Stephenson Co., June 9, a resolution was passed in favor of a law, making permanent roads a county matter, and to authorize the issue of county bonds for that purpose. It also expressed the opinion that the Board of Supervisors of this county should make a levy of 20 cts. per $100 on all taxable property of this county, said levy to be appropriated for building permanent roads under the direction of a committee of said board and the Commissioner of Highways in the town in which the improvement is made.

WASHINGTON.—The County Commissioners of Pierce Co. are receiving bids for 10½ miles of road, and other roads are projected. The county will spend $60,000 on road improvements this year.

BRIDGES, TUNNELS AND CANALS.

LAWRENCE, MASS.—At a meeting of the Common Council the order for the construction of a bridge across the Spicket River at Bennington St. was adopted. The order authorizing the committee to have plans prepared and solicit bids for the Short St. bridge was also adopted.

WILLIMANTIC, CONN.—An iron bridge is to be substituted for the old wooden one on the Providence Division of the New York & New England R. R. on South Main St.

NEW YORK, N. Y.—The New York Central R. R. proposes to build a bridge over the Tonawanda Creek, which will be 500 ft. long and contain five spans.

BUFFALO, N. Y.—Sealed proposals will be received until June 22 at office of Dept. of Pub. Wks. for constructing a steel arch bridge, masonry, retaining walls and filling complete on Elmwood Ave. over Scajaquada Creek. Plans on file at the office of Chief Engineer, Edwin F. Bishop, Secy.

PATERSON, N J.—The committee appointed to inquire into the necessity of a bridge in the vicinity of Little Falls has reported a bridge needed and estimates the cost to be $7,000 for superstructure, $3,500 for masonry. Proposals will be advertised for to construct the bridge. The committee was also authorized to have plans prepared for the bridge at West Side Park.

HACKENSACK, N. J.—At a meeting of the Councilmen, Mr. Tehune asked for an appropriation to build a bridge at Shadyside to cost $1,200. Petition granted. Alderman Dennett applied for a $1,200 bridge across the Saddle River in Orvil Township. The matter was decided by vote, and bridge will be built. Bridge Commissioner Outwater askes for a reconsideration of resolution passed on May 26 to repair the Hilsdale bridge, and on motion of Mr. Green the committee was authorized to build a $2,000 iron bridge.

MANAYUNK, PA.—The Pennsylvania R. R. Co. will substitute a stone bridge for the present high trestle work on which the tracks cross near West Laurel Hill.

OIL CITY, PA.—The steel railway bridge between Oil City and Rousenville is so badly damaged by the floods that it will have to be replaced by a new one.

TITUSVILLE, PA.—The Titusville "Citizen" states that the Pennsylvania R. R. Co. will soon put in a new draw on the Bay bridge.

NORRISTOWN, PA.—Sealed proposals will be received until June 21 for the repairs of a stone bridge over Sawmill Run Creek on the Germantown pike. Samuel R. Anders and Chas. D. Loch, Comrs.

McKEESPORT, PA.—A $50,000 bridge is to be constructed to connect Boston and Grenoak near here. A $6,000 bridge will also be constructed between Suter and Douglas, and a railway bridge will be built to connect the Waverly Coal Co. with the Pittsburg, McKeesport & Youghiogheny R. R.

HARRIMAN, TENN.—A bridge to cost $14,000 is to be built over the Emery River at this place.

ST. AUGUSTINE, FLA.—The St. Augustine Bridge Co. has been incorporated by W. W. Dewhurst, Matthew Hays, Allen Wood and others, to build, maintain and operate a toll bridge between St. Augustine and Anastasia Island. The capital stock is $50,000.

KNOXVILLE, TENN.—At a meeting of the Cherokee Land Co., of Knoxville, Tenn., the contract for the bridge across the Tennessee River at this city was awarded to the Groton Bridge & Mfg. Co., of Groton, N. Y., for $69,332. The bridge will consist of 13 50-ft., two 150-ft. and one 200 ft. spans, with 20-ft. roadway

and two 6-ft. walks and iron substructure. The same company also has the contract for the Oak St. bridge for this city at $21,000.

DELAWARE, O.—Proposals will be received until July 7 at the office of the Board of Commissioners for the construction of a stone arch bridge over the run in Berlin Township. John J. Ramage, Co. Aud.

LANCASTER, O.—Bids will be received until July 5 at office of R. F. Brown, Aud., for masonry for two abutments and for the superstructure of a bridge in Greenfield township. The distance between abutments at top is 50 ft. Height from 12 to 15 ft. No bids will be considered on superstructure except for all iron and covered bridges.

TOLEDO, O.—The Pennsylvania R. R. Co. has purchased land along the river front of the city. The intention is to build coal and iron ore docks at an estimated cost of $500,000.

MONROE, WIS.—The City Clerk has been authorized to advertise for proposals for the construction of an abutment at the north end of the Monroe St. bridge.

MILWAUKEE, WIS.—Plans have been accepted for a 3-span iron highway bridge over the North Ravine in Lake Park, and bids for construction will probably be received soon.

WATER WORKS.

New England.

BANGOR, ME.—The Council has requested the Public Works Co. to erect a stand-pipe.

PENACOOK, N. H.—The Michigan Pipe Co., Bay City, has the contract for gravity works, with 11½ miles of Wyckoff pipe; price, $65,000.

ATTLEBORO, MASS.—The district has voted $55,000, of 4%, 10 to 30 years bonds, for a new pumping station and appurtenances in the valley of the Seven Mile River, near Orr's Pond; also $10,000 for new mains.

MARLBORO, MASS.—Authority to take Milham Brook for a new supply is being sought.

NORTH SMITHFIELD, R. I.—A petition has been circulated asking that the mains of the Woonsocket Works be extended to this place.

WATERBURY, CONN.—Engineer R. Hering, New York, has recommended a new supply from Mad River.

Middle.

ALTAMONT, N. Y.—A water supply will be secured from a spring 2½ miles west of the village it is reported.

AUBURN, N. Y.—The city has voted, 2,827 to 636, in favor of municipal ownership. A company now supplies the city.

NEW YORK, N. Y.—The Aqueduct Commissioners have postponed the date of opening bids for the construction of the Cornell dam from June 15 to June 29. The proposed dam was described and illustrated in our issue of June 2.

POUGHKEEPSIE, N. Y.—New pumps and boilers are talked of.

PERTH AMBOY, N. J.—The Council has accepted the offer of the Perth Amboy Water Co, to sell its works to the city for $40,000. Contracts have been let by the city for a new supply. The company fought the city's attempt to acquire works.

PLAINFIELD, N. J.—The State Supreme Court has declared illegal the water and sewerage franchises, granted last year by the "Combine" to J. M. Low, of Kingston. A company already supplies the city.

WOODSTOWN, N. J.—At a special election the Borough Council was authorized to bond the Borough for $30,000 for works.

ALTOONA, PA.—Steps are being taken to issue $220,000 of bonds for a new impounding reservoir at Kittaning Point. The bonds have been voted.

ERIE, PA.—It is reported that a pump will be added.

HOMESTEAD, PA.—The Water Committee will expend $20,000 for pipe.

LAFAYETTE, PA.—It is reported that the Council will order a special election to vote on the levying of a tax for works.

SHENANDOAH, PA.—It has been voted to increase the borough debt $95,000 to establish water-works.

SUSQUEHANNA TOWNSHIP, PA.—The McKee Water Co. has been incorporated; Treas., Wm. K. Alricks; capital stock, $20,000. Principal office at Harrisburg.

WILMINGTON, DEL.—The contract for a 600,000-gallon Church air lift pump has been awarded to a company of the same name, for $2,200.

Southern.

HARRODSBURG, KY.—The Harrodsburg Water Co. turned on the water June 10. The town pays $3,500 for 75 fire plugs.

HENDERSON, N. C.—The water-works system was completed May 26, and accepted by the City Council after a satisfactory test had been made. The plant consists of about nine miles of 6 to 16-in. cast iron pipe, two compound duplex Deane steam pumps of 1,000,000 gallons capacity each, two 75-H.P. tubular boilers built by Tippett & Wood, of Phillipsburg, N. J., who have also erected the standpipe, 15 ft. by 130 ft. The supply is taken from Fox's Pond, a storage reservoir holding about 50,000,000 gallons. There are 68 fire hydrants, Ludlow pattern. The contractors are Woltmann, Keith & Co., New York, N. Y.

GREENSBORO, N. C.—J. D. Glenn has been appointed Receiver of the Greensboro Water Co., with authority to complete the works.

ORLANDO, FLA.—A dispatch states that the company's works have been sold at a foreclosure sale to Harry W. Lentz, Williamsport, Pa., for $100,000.

North Central.

ALLIANCE, O.—It is reported that from $50,000 to $75,000 will be expended by the company for improvements, including a new pumping station and standpipe.

WAPAKONETA, WEST MILTON and WYOMING, O.—Plans for water-works at these places are being prepared by John W. Hill, Cincinnati, O.

LEBANON, O.—Works are talked of.

CHARLEVOIX, MICH.—The contract for the water-works was let June 8 to the Lansing Iron & Engine Works. It includes the furnishing and laying of about 5¼ miles of 4 to 10-in. pipe, two Worthington duplex pumps of 750,000 gallons capacity each, two tubular boilers 14 ft. long and 5 ft. diameter, 47 hydrants and 27 valves and valve boxes. G. L. Wells, Grand Rapids, Mich., is Designing Engineer. The detail prices are given in another column, under the head of "Contract Prices."

JACKSON, MICH.—Engineer J. D. Cook, Toledo, O., has reported that the water supply should be increased, new pumping machinery added, and the distribution system extended.

L'ANSE, MICH.—The contract for works has been let to E. T. Sykes, Minneapolis. Bonds to the amount of $15,000 have been sold. Iron mains will be used.

NORWAY, MICH.—It is proposed to build works at a cost of about $70,000.

PORT HURON, MICH.—Bids are wanted by Pres., Water Comr. J. G. O'Neill, until June 22, for 300 tons of 8, 6 and 4-in. cast iron mains, five tons of specials and ten tons of pig lead.

BELLEVILLE, ILL.—It is reported that the Council has granted to A. F. Farnum and others, of New York, a franchise for works, provided that a supply be introduced from the Mississippi or Kaskaskia rivers. The city will pay $25,000 per year for water. The present supply is said to be inadequate.

CHICAGO, ILL.—The 14th St. pumping station has been opened, giving an increase of 45,000,000 gallons to the city's daily water supply.

WILMETTE, ILL.—The town will probably buy water from Evanston for 8 cts. per 1,000 gallons.

Northwestern.

IOWA FALLS, IA.—Bids for constructing works will be received until June 20.

DULUTH, MINN.—An ordinance has been introduced in the Council providing for the introduction by the company of high service to a point 500 ft. above the lake by November, 1893.

TRACEY, MINN.—June 21 bids will be received by Mayor M. Thurin for 9,800 ft. of 10 to 4-in. cast iron pipe, 23 hydrants; 20 valves; 1,000,000-gallon duplex pump, and a deep well pump; steel boilers; 18 × 30 ft.; wooden tank on 84-ft. wooden tower; brick reservoir 32 ft. in diameter by 20 ft. deep.

O'NEILL, NEB.—The people have voted $15,000 of bonds for works.

WAKEFIELD, NEB.—There is talk of issuing $7,000 of bonds for works.

Southwestern.

VAN BUREN, ARK.—Address City Clerk, E. Matlock, regarding works.

OKLAHOMA, OKLA. T.—The Consulting Engineer for the Oklahoma Water-Works Co. is Lewis Kingman, of Topeka, Kan. The company proposes to lay 6 miles of main, and to put in a pumping plant of 2,000,000 gallons daily capacity.

CAMERON, TEX.—Works are still talked of.

DALLAS, TEX.—The city will probably buy 26 hydrants.

FLATONIA, TEX.—The Southern Improvement Co. is figuring on water and electric lighting plants.

HUNTSVILLE, TEX.—A committee has been appointed to look into the question of securing water-works.

WAELDER, TEX.—Works are talked of.

Pacific.

KENT, WASH.—The people have voted $23,500 for a water and electric lighting plant.

Canada.

FREDERICTON, N. B.—The addition of a small pumping engine is under consideration.

SYDNEY, P. E. I.—The town has decided to build works. The supply will be from an impounding reservoir. Engr., J. A. Pickett.

ST. LAMBERT, P. Q.—A water and drainage scheme is under consideration.

IRRIGATION.

NEW COMPANIES.—North Fork Canal Co., Delta Co., Colo.; Directors, Chas. E. Taylor, W. H. Malone and others; $200,000. Alta Land & Water Co., Grand Junction, Colo.; A. Struthers, C. W. Baldwin and G. Smith, $100,000.

SEWERS.

BENNINGTON, VT.—An engineer from Boston is in town with a view of estimating the cost of a complete sewer system.

BOSTON, MASS.—The Metropolitan Sewerage Commissioners will receive bids until June 25 for section 7 of the main sewer in Winthrop and East Boston. The work includes a 9-ft. sewer, siphon, sand catcher, etc.; brick, concrete and squared stone masonry; piles and a coffer-dam; length about 800 ft. The contract for section 41 has been awarded to Moulton & O'Mahoney. The prices are printed in another column.

BROCKTON, MASS.—The city sewerage bill has been signed by the Governor. The city asked to be allowed to take land in Brockton, Easton and West Bridgewater for use as sewerage disposal fields. The bill, as finally passed by the House, denies disposal fields except within the town limits, but allows the location of a pumping station and laying of a force main through a portion of West Bridgewater.

PROVIDENCE, R. I.—The Committee on Sewers has voted to construct sewers in 11 streets.

AUBURN, N. Y.—The City Clerk will receive bids until June 20 for the sewer in Ward 5.

JERSEY CITY, N. J.—The Street and Water Commissioners have approved the plans for the Woodlawn sewer in West Bergen; estimated cost about $61,000. Construction will begin at once.

ORANGE, N. J.—Bids are asked until June 27 for eight miles of 8 to 24 in. pipe sewers. C. P. Bassett is Chief Engineer. See advertisement.

LANSDOWNE, PA.—The Lansdowne Sewage Co. has been incorporated by E. T. Darby, H. Guilford, and others; capital, $5,000.

PHILADELPHIA, PA.—The Council has accepted a loan of $250,000 from the Girard estate for the construction of a sewer in Spunk Ave. and Passyunk road.

CLIFTON FORGE, VA.—The Council has voted to employ an engineer to examine the drainage of the town, with a view to introducing a general sewerage system.

PIQUA, O.—The City Clerk will receive bids until July 2 for sewer extensions.

CLEVELAND, O.—Bids are asked until June 22 for a sewer in Burton St. R. R. Herrick, Director Pub. Wks.

COLUMBUS, O.—The Board of Public Works will receive bids until June 20 for about 5,600 ft. of 24 to 54-in. main sewer.

MARIETTA, O.—Plans for a system are being prepared by John W. Hill, Cincinnati.

TIFFIN, O.—The City Engineer is preparing plans for sewer extensions.

HUNTINGTON, IND.—Bids are asked until July 5 for sewer drains. Wm. Schwartz, Cy. Clk.

EATON RAPIDS, MICH.—L. A. Bently will receive bids until June 23 for sewer construction.

BELLEVILLE, ILL.—The Mayor has been instructed to secure plans for a complete system of sewerage for the city.

CICERO, ILL.—Plans have been prepared for a system to cost $350,000.

CEDAR RAPIDS, IA.—A contract has been awarded to Spencer Jackson at $36,550.

EMPORIA, KAN.—The City Clerk will receive bids until June 20 for 8,250 lin. ft. of 5-in. sewer.

OMAHA, NEB.—The City Engineer has prepared plans for sewer extensions; estimated cost, $367,000 to $421,000.

SPOKANE, WASH.—Contracts have been awarded to R. A. Jones at $27,806, and the Washington Pipe Co. at $4,000 for pipe.

STREETS.

MALDEN, MASS.—The Board of Trade has voted unanimously in favor of paving the principal streets.

BROOKLYN, N. Y.—Bids are asked until June 28 for repaving four streets with granite blocks. J. P. Adams, Comr. Cy. Wks.

NEW YORK, N. Y.—The Commissioner of Street Improvements of Wards 23 and 24 will receive bids until June 27 for four contracts for paving and sewers.

BINGHAMTON, N. Y.—Court St. is to be paved with asphalt; estimated cost $40,000.

BUFFALO, N. Y.—The Department of Public Works will receive bids until June 28 for 10 contracts. Additional work has been ordered to cost about $190,000.

NUTLEY, N. J.—The Clerk of the Town Committee has been instructed to ask for bids for macadam and telford roads.

CHARTIERS BOROUGH, PA.—Bids are asked until June 21 for paving three streets with brick. John Kumpf, Chn., St. Com.

CINCINNATI, O.—The Board of Administration will receive bids until July 9 for paving one street each with brick and macadam.

DEFIANCE, O.—The City Council is visiting other cities to study the subject of street paving.

MANSFIELD, O.—Bids are asked until July 9 for three contracts. F. M. Renny, Cy. Clk.

ZANESVILLE, O.—Plans and specifications have been accepted for paving 11 streets, and proposals will be received until July 7. W. M. Shinnick, Cy. Clk.

FORT WAYNE, IND.—Bids are asked until June 28 for 20 contracts, mostly grading and brick sidewalks. F. M. Randall, Cy. Engr.

ROCK CREEK, ILL.—Bids will be received until June 25 for about 50 rods of macadamized road. C. P. Peterson, Clk.

STREATOR, ILL.—The Council has voted to pave Monroe St. with brick.

DULUTH, MINN.—Bids will be asked for paving 21 blocks of Superior St.

OAKLAND, CAL.—The Council has ordered the improvement of six streets, by macadamizing, curbing, etc.

ELECTRICAL.

WOONSOCKET, R. I.—The contract for city lighting will expire July 1, and the Committee on Lights has been authorized to confer with different companies concerning a new contract.

PETERSBURG, PA.—The City Council has voted to own and operate its own electric light plant.

SHARPSBURG, PA.—The citizens have voted in favor of a plant to cost about $15,000.

WHEELING, W. VA.—A committee has been appointed to prepare plans for a municipal plant. Bonds will be issued.

NASHVILLE, TENN.—The only bid received for lighting the city with electricity was that of the Thomson-Houston Co., 27.4 cts. per light per night.

BELLEVILLE, ILL.—A contract for 100 lights for five years has been awarded to the Belleville Electric Light & Coal Co. at $100 per light per year.

GONZALES, TEX.—It is reported that a plant will be established by T. S. Walker.

KENT, WASH.—The city has voted to issue bonds for $23,500 for water-works and electric light plant.

NEW COMPANIES.—Forest City Electric Light, Heat & Power Co., Forest City, Pa.; $1,000; Treas., H. O. Watrous. New York Power Co., Newark, N. J.; $100,000; E. A. Hopkins, Philadelphia, Pa.; L. H. Miller, Norway Water Power & Electric Light Co., Norway, Me.; Pres., C. N. Tubbs; Treas., F. H. Noyes. Delta Electric Co., Cairo, Ill.; $150,000; Henry Hosenjager, Wm. Kluge.

CONTRACT PRICES.

WATER-WORKS AND WELL.—Charlevoix, Mich.—The following contract has been awarded to the Lansing Iron & Engine Works: About 5¼ miles of pipe, 4-in., $28.25 per ton; 6 to 10-in. $27.50; special castings, 2¾ cts. per lb.; Crane Co.'s hydrants, $27.50 each; 4-in. valves, $7.20 each; 6-in., $11.25; 8-in., $17.50; laying pipe, 4-in., 14 cts. per lin. ft.; 6-in., 17 cts.; 8-in., 18cts.; 10-in., 19 cts.; river crossing, 143 ft. of 10-in. pipe and 12 flexible joints, $475. The contract for the artesian well, 8 ins. diameter, was awarded to Z. Mason, Bay City, at $1.50 per ft.

DREDGING & PIER WORK.—New York, N. Y.—

The Department of Docks will receive bids until June 30 for dredging about 12,850 cu. yds.; a new crib bulkhead; new pier; sewer box, etc.

RETAINING WALL.—Lynchburg, Va.—Bids are asked until June 20 for a retaining wall in Pierce St. L. P. Rodes, Cy. Engr.

CEMENT.—Philadelphia, Pa.—Maj. C. W. Raymond has awarded the contract for 2,700 bbls. of cement for Pea Patch Island to Michael Herron, Bordentown, at $1.12 per bbl., delivered in one lot.

CHICAGO DRAINAGE CANAL.—Chicago, Ill.—The Drainage Board has opened the bids for the construction of the canal, the specifications for which were given in our issue of June 2. The quantities are 11,500,000 cu. yds. of rock excavation, 5,000,000 cu. yds. of earth excavation, 287,241 cu. yds. of dry rubble wall, 244,414 sq. yds. of slope paving. On rock excavation the range was from 65 cts. per cu. yd., bid by McArthur Bros., to $1.65 by John Griffiths, of Chicago, with an average of about 75 cts. Engineer Williams' estimates for rock excavation were 65 cts and 75 cts. On glacial drift the range was from 20 cts. bid by McArthur Bros. and Green & Butler, of Petoskey, Mich., to 70 cts. bid by John Griffiths, of Chicago, with an average of 30 cts. Engineer Williams' estimate was 26 cts. for glacial drift. There were 26 bidders, of whom the following were the lowest bidders on certain sections: (1) McArthur Bros., Chicago; (2) Agnew & Co., Chicago; (3) E. D. Smith & Co., Baltimore, Md.; (4) Albert Harley, Chicago; (5) Mason, Hodge & Co., Frankfort, Ky.; (6) McCormick Construction Co., St. Louis, Mo. The other bidders were as follows: McDowell Bros. & Co., Grand Rapids, Mich.; E. J. Gaynor & Son, Pottsville, Pa.; Thomas H. Riley, Joliet; Heidenreich & Co., Frankfort, Ky.; Green & Butler, Petoskey, Mich.; Michael Lally, Detroit; John Griffiths, Chicago; Thomas Rock, Chicago; Lynch, Phelps, Shafer & Harding, Monmouth, Ill.; O'Hearn, Lee & Strange, Kansas City; John Scott & Son, St. Louis; H. B. Herr & Co., Chicago; Winston Bros. & McMullen, Minneapolis; R. F. Wilson, Chicago; John Shields, Flemington, N. J.; M. J. Condon & Co., Knoxville, Ky.; Darvin S. Dugan, Oswego, N. Y.; Quigley & Moore, St. Louis; Streeter & McGavick, Denver, Colo.; Lydon & Davis, Chicago. One of the 26 bidders McArthur Bros., alone sent in a complete set of bids, covering the entire seventeen miles in each proposition. The approximate lowest bids in each section were as follows:

	Earth excav. and refill.			Masonry.				Spruce lumber	Spruce piles	Malden pipe	
				Brick.		Concrete.					
	20×30 ins.	25×28 ins.	22×33 20×30 ins.	Am.	Port.	Am.	Port.	Rubble. Am.	in place. driven.	sewer.	
	1,000	1,750	6,370	600	500	250	100	50	10M.	1,000	1,000
	Lin. ft.	Lin. ft.	Lin. ft.	Cu. yds.	Cu. yds.	Cu. yds.	Cu.yds.	Cu.yds.	Ft.B.M.	Lin. ft.	Lin. ft.	Total.
	$	$	$	$	$	$	$	$	$	Cts.	Cts.	$
1...	6.20	6.20	6.20	13.00	15.25	5.50	7.75	5.00	35	20	15	79,170
2...	6.00	5.00	5.00	13.50	15.50	6.00	7.50	6.00	40	20	25	69,825
3...	2.35	4.00	5.50	16.50	18.00	6.40	8.00	4.50	35	15	75	68,756
4...	4.00	4.20	5.00	16.00	17.00	5.50	7.00	5.00	30	20	80	68,609
5...	4.40	4.40	4.40	15.00	17.00	5.00	7.15	5.25	40	15	60	48,341
6...	3.00	3.00	3.00	13.25	15.15	5.25	7.00	5.00	40	25	40	63,806
7...	2.35	2.45	2.15	13.45	15.25	5.25	7.00	5.00	45	15	50	40,971
8...	2.05	1.65	1.75	14.50	17.00	6.50	8.50	6.50	33	40	20	38,380

Sect.	Proposition No. 1 Bidder.	Proposition No. 1 Price.	Proposition No. 2 Bidder.	Proposition No. 2 Price.	Proposition No. 3 Bidder.	Proposition No. 3 Price.
1	1	$201,250	4	$764,325	1	(Total for
2	1	650,779	1	646,963	1	ten sec-
3	1	542,704	1	741,034	1	tions by
4	1	573,521	1	729,841	1	McArthur
5	1	972,289	2	522,141	1	Bros.)
6	1	632,172	2	604,487	1	$11,900,000
7	1	567,413	2	622,791	4	700,000
8	1	696,851	2	895,289	1	.....
9	2	860,168	2	996,574	5	852,000
10	3	849,055	3	1,002,645	1	.....
11	1	679,409	5	820,334	1	.....
12	1	681,163	5	812,756	1	.....
13	1	704,099	2	760,094	5	724,000
14	1	698,104	2	788,226	6	755,000
15	3	936,286	..	.....	3	947,000
16	3	456,423	..	.....	3	575,000
17	..	.....	..	.....	1	.....
Total	—	$10,654,733	..	$10,717,553	—	$16,453,000

It is stated that the unofficial figures published show that on Propositions Nos. 1 and 3 bids range considerably above the estimates of Mr. Williams, the Chief Engineer, while for Proposition No. 2 they are about the same. Propositions 1 and 3 contemplate the construction of a large water power at Lockport, but the excess of the bids over the estimates is said to point to an abandonment of that project and the showing of the unofficial figures makes Proposition 2 the feasible route as far as the cost of construction is involved and vindicates the policy of Mr. Cooley, whose ideas are embodied in that proposition, and under which the Sanitary District furnishes the pumping plant and does the pumping, furnishes cars, and hauls away the waste material, consequently there must be added to the total above, in order to make a just comparison with other routes, an amount sufficient to cover this, which is estimated at $6,800,000, making a total under Proposition 1 of $16,800,000.

Under Proposition 2, the contractor is to do the entire work, and to the total given in the table must be added an estimate of $1,500,000 for five miles of tail race necessary to carry the channel from Lockport, where it stops under the proposition, to Joliet, making a grand total of $12,217,582.76.

Proposition 3 also includes a water power at Lockport, but differs from Proposition 1 in that the contractor does his own pumping and transporting of waste. The figures given above are liable to change when the official figures become known, since many of the bids were very close. On separate items, however, there was a wide divergence in prices: 65 cts to $1.65 for rock, 20 to 70 cts. for earth, $1.66 to $2.33 for retaining wall, and 75 cts. to $3 for slope paving.

MASONRY, LUMBER, ETC.—Columbus, O.—Bids are asked until July 3 for about 243 perches of sandstone masonry, dressing and pointing about 100 sq. yds. of sandstone masonry, 12,855 ft. of lumber, 30 yds. of concrete, 100 perches of rip-rap, 3,000 yds. of filling, and 2,000 yds. of gravel. H. J. Caren, Co. Aud.

WATER-WORKS SUPPLIES.—Rochester, N. Y.—The contract for cast iron water pipe and special castings has been awarded to the Lake Shore Foundry Co., Cleveland, O., as follows: 6 tons, 16-in.; 7 tons, 12-in.; 136 tons, 10-in.; 304 tons, 8-in.; 402 tons, 6-in.; 58 tons, 4-in.; all at $21.20 per ton, and 50,000 lbs. specials, 2¼ cts. per lb.

Salt Lake City, Utah.—The lowest bids for 585 tons of 16-in pipe, and 52 tons of 8-in., were those of Rhodes Bros., $19,685 and $1,812 respectively, or furnishing and laying 16-in pipe, $2.62 per lin. ft.

SEWERS.—Boston, Mass.—The Metropolitan Sewerage Commission has received the following proposals for section 41 of the main sewer, in Malden and Melrose. The approximate length is 9,780 ft.; average depth, 11.9 ft.; and external diameter, 40 to 45 ins. The bidders were: (1) Jones & Meehan, Jamaica Plain; (2) Everson & Liddle, Providence, R. I.; (3) F. A. Snow, Providence, R. I.; (4), John Sheehan, Lynn; (5) Christy McBride, Brighton; (6) Metropolitan Cons. Co., Boston; (7) National Cons. Co., Boston; (8) Moulton & O'Mahoney, Boston, to whom was awarded the contract.

STREET WORK.—Milburn, N. J.—The following contract has been awarded for repairing the turnpike: P. H. Hamson & Son, macadamizing, 65 cts. per cu. yd.; grading, 30 cts.; filling railroad cut, 20 cts.

Jersey City, N. J.—Two contracts have been awarded to Albert Minardo at the following prices: Rock excavation, 5 cts. and ¼ ct. per cu. yd.; earth excavations, 5 cts., 2 cts.; earth filling, 5 cts.; sand and grade filling, 80 cts., 85 cts.; paving, 90 cts., 85 cts. per sq. yd.; curb reset, 5 cts., 3 cts. per lin. ft.; manholes brought to grade, $1 each; new curb, 60 cts. per lin. ft.; bridge stone, 40 cts. per sq. ft.; flagging, 13 cts.; repaving, 10 cts.; relaying bridge stone, 3 cts.; relaying flagging, 2½ cts.; curbing, 5 cts. per lin. ft.; resetting basins, $1 each.

MISCELLANEOUS.

DAM.—New York, N. Y.—The date for opening the bids for the construction of the Cornell dam has been postponed by the Aqueduct Commissioners from June 15 to June 29. The dam was described and illustrated in our issue of June 2.

DREDGING.—Brooklyn, N. Y.—Bids are asked until June 21 for dredging both channels at Metropolitan Ave. bridge. J. P. Adams, Comr. Cy. Wks.

PARK IMPROVEMENTS.—New York, N. Y.—The Department of Public Parks will receive bids until June 22 for improving the public place at 110th St. and 5th Ave.; furnishing and setting 3,134 lin. ft. of granite coping and posts at Mt. Morris Park; 3,134 lin. ft. of iron railing, and erecting a music stand at same place.

POWER HOUSE, FLUME, ETC.—Rat Portage, Man.—The Citizens' Telephone & Electric Co. will receive bids until June 27 for a power house, flume and penstock, and excavating rock for a raceway.

SAND.—Philadelphia, Pa.—Bids will be received at the U. S. Engineer Office until June 25 for 9,000 cu. yds. of sand for the fort opposite Fort Delaware, and 12,000 cu. yds. for Pea Patch Island. Maj. C. W. Raymond, U. S. A.

STEEL PLATES, ETC.—Washington, D. C.—Bids will be received at the Bureau of Provisions and Clothing, Navy Dept., until June 21 for 89,738 lbs. steel plates, 38,377 lbs. steel shapes, 63,000 ft. yellow pine, also engines, dynamo, motor, etc., for the New York Navy Yard; steel castings, forgings, lumber, etc., for the Washington Navy Yard; and machinery, tools, hoisting engine, lumber, etc., for the League Island Navy Yard. Edwin Stewart, Paymaster-General, U. S. N.

GAS.—Bayonne, N. J.—The Bayonne Gas Light & Fuel Co. has been incorporated by A. W. Munkittrick, Madison, and L. W. Johnson and R. Batcheler, New York; capital, $200,000.

BOILERS, STONE AND PIER.—Ottawa, Ont.—Bids are asked until June 24 for two cylindrical straightway boilers; and until June 30 for quarrying and delivering rubble and dimension stone from the Penitentiary quarry, St. Vincent de Paul, for one year, and for extending and strengthening the south pier at Big Mimingash. E. F. E. Roy, Secy., Dept. Pub. Wks.

BONDS.—Detroit, Mich.—The City Controller receives bids until June 16 for $105,000 of park and boulevard bonds.

Portland, Ore.—The Board of Commissioners of the Port of Portland will receive bids until June 25 for $100,000 of the bonds of the Port of Portland, of which $500,000 are authorized to be issued for river improvements.

Ashland, Wis.—The City Clerk will receive bids until June 25 for $75,000 of improvement bonds.

CEMENT.—Washington, D. C.—The District Commissioners will receive bids until June 23 for natural hydraulic cement for one year.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have orders for 10 consolidation and 5 ten-wheel engines for the Norfolk & Western, 5 ten-wheel engines for the Chicago, Rock Island & Pacific, 10 express passenger engines for the Baltimore & Ohio. The Lima Locomotive & Machine Works, Lima, O., have built a heavy Shay geared locomotive for the Saco Valley Lumber Co., Bartlett, N. H. The Brooks Locomotive Works, Dunkirk, N. Y., are building engines for the Great Northern, the Wisconsin Central and the Chicago, Rock Island & Pacific; one of their engines for the Iron Range & Huron Bay is illustrated elsewhere. The Atchison, Topeka & Santa Fe has received three new engines for the Rio Grande division.

CARS.—The Ensign Car Mfg. Co., Huntington, W. Va., has an order for 500 box and flat cars for the Southern Pacific. The North Carolina Car Co., Raleigh, N. C., is building stock and freight cars for the Seaboard Air Line. The Wagner Palace Car Co., Buffalo, N. Y., is making arrangements to manufacture 12 cars per month in consequence of the demand for equipment for the World's Columbian Exposition traffic. All these cars will be lighted by the Pintsch compressed gas system. The Pullman Palace Car Co., Chicago, Ill., has the following contracts on hand: 100 passenger cars for the Philadelphia & Reading; 2 dining cars and 20 passenger cars for the Chicago, Rock Island & Pacific; 22 passenger cars for the Southern Pacific; 6 parlor cars for the Chicago & Northwestern; 5 passenger cars, 5 combination passenger and baggage and two vestibuled dining cars for the New York, Lake Erie & Western; 2 combination passenger and baggage cars for the Chicago, St. Paul, Minneapolis & Omaha; a private car for Mr. J. J. Hagerman, President of the Pecos Valley; a private car for the Minneapolis, St. Paul & Sault Ste. Marie, and another for the Baltimore & Ohio; 25 passenger cars for the Central of New Jersey; 1 parlor car for the Windsor & Annapolis; 25 passenger, 10 express, 10 mail, 1,000 box and 400 coal cars for the Norfolk & Western; 3 passenger cars and 1 combination passenger and baggage car for the Cleveland & Marietta.

CONSOLIDATED CAR HEATING CO.—At the annual meeting of this company on June 7 a semi-annual dividend of 1½% was declared. Vice-President Wm. G Rice reported that sales had averaged over $1,000 per day for every working day of the past year, including the output of the Canadian factory at Coaticook, Que. The Sewall coupler and McElroy commingler were reported in use on railways having an aggregate length of 45,071 miles and owning 11,204 passenger cars. During the year 16,471 of these couplers have been sold. The old officers of the company were re-elected.

THE BERLIN IRON BRIDGE CO., of East Berlin, Conn., has designed and will build the new foundry building for Samuel F. Hodge & Co., Detroit, Mich. The building will be 86×161 ft., with a wing 23 ft. in width on each side. In the center of the building is a traveling crane with a travel the full length of the building. In the wings of the building are jib cranes, so that the entire floor surface will be controlled by power, either from the traveling crane or from jib cranes. The construction will be entirely of brick and iron.

THE LIDGERWOOD MFG. CO., of New York, making hoisting engines and cableways, reports having shipped 127 engines and 45 boilers during the month of May, an average of 5 engines per day. Mr. John Best, engineer, of Lancaster, Pa., has been appointed the company's agent for Lancaster and the vicinity.

NEW COMPANIES.—International Tin Plate & Refining Co., Chicago., Ill.; $200,000; Louis Benjamin and R. H. Buckingham. Tight Joint Co., New York, N. Y.; $100,000; Henry Ciausen, Jr., DeWitt Clinton and A. J. Dittmar. Cullen & Rhoderick Engineering Co., Paterson, N. J.; $25,000; to build street railways, etc.; G. W. Arenston, G. G. Rhoderick and W. A. Cullen. Western Construction Co., Baltimore, Md.; A. E. Hatch, J. H. Laurence and Chas. G. Campbell. International Phosphate & Fertilizer Co., Chicago, Ill.; $1,000,000; Percival Dorset, C. L. Mitchell and W. T. Hardenbrook. Columbus Construction Co.; $500,000; and Ohio Construction Co.; $500,000; Chicago, Ill.; Andrew Spear, Jr., Geo. F. Randall and Wm. Kendall. Denver Cement Co., Denver, Colo.; $250,000; J. P. Heisler, R. W. Steele and Rodney Curtis. Occidental Bridge & Construction Co., Kansas City, Mo.; $50,000; J. A. L. Waddell and Lee Treadwell. Harvey Automatic Safety Switch Co., Camden, N.J.; $50,000; J. L. Harvey, W. Lindig and S. R. Reed, of Philadelphia. Rohlf Pickford Bridge & Crossing Safety Gate Co., Chicago, Ill.; $100,000; H. J. Rohlf, Walter Pickford and George R. Freak. Esmond Street Rail Co., New York, N. Y.; $1,500,000; incorporated in West Virginia; Ernest R. Raymond.

CURRENT PRICES.

RAILS.—New York: $30 at Eastern mills, $30.75 at tidewater; old rails, $17 for iron and $13 for steel. Pittsburg: $30; old rails, $19 for iron and $15.25 to $16.25 for steel. Chicago: $31 to $31.50; old rails, $18 to $18.50 for iron and $12.50 to $13 for steel.

TRACK MATERIALS.—New York: steel angle bars 1.6 to 1.7 cts.; spikes, 2 to 2.05 cts.; track bolts, 2.65 to 2.75 cts. with square and 2.8 to 2.85 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.8 cts. for iron and 1.8 to 1.9 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 cts. for iron and 1.75 cts. for steel; spikes, 2.1 to 2.15 cts.; track bolts, 2.55 cts. with square and 2.62 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing 55 per cent.

FOUNDRY PIG IRON.—New York: $14 to $16. Pittsburg: $13.50 to $14.75. Chicago: $13.50 to $15.

LEAD.—New York; 4.15 to 4.2 cts. Chicago: 4.12 cts. St. Louis: 4 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.1 to 2.5 cts. for large lots, and 2.25 to 2.65 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.9 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.85 to 1.95 cts. for tank, 2.05 to 2.25 cts. for shell, 2.35 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 1.9 to 1.95 cts. for large lots, and 2 to 2.1 cts. for small lots; channels, 1.9 to 1.95 for large lots, and 2 to 2.1 cts. for small lots; angles, 1.85 to 1.9 cts.; tees, 2.4 cts.; universal mill plates, 1.8 to 1.9 cts. for iron and steel; sheared steel bridge plates, 1.95 to 2 cts.; refined bars, 1.7 for iron and 1.75 cts. for steel; steel plates, 1.75 to 1.85 cts. for tank, 2 to 2.1 cts. for shell, 2.05 to 2.15 cts. for flange, 3.5 to 3.75 cts. for firebox. Chicago: beams, 2 to 2.05 cts.; channels, 2 to 2.05 cts.; angles, 1.85; tees, 2.4 cts.; universal plates, 1.9 cts.; sheared steel plates, 1.8 to 1.9 cts. for iron and steel; sheared steel plates, 1.95 cts.; steel plates, 2.3 to 2.4 cts for tank, 2 to 2.75 cts for shell, 2.9 to 3 cts. for flange.